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QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association.

(INTERNATIONAL.)

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Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Insurance Bureau.
Western Sprinklered Risk Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.

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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

This remarkable photograph taken during the beach resort conflagration at Hull, Mass., on the night of March 27, 1923, is a striking illustration of ignition by heat radiated from a nearby burning building. As can be seen in the picture there is no direct contact of flame.

Which May Burn First?

Toulon, in France, with 150,000 population has only 150 frame buildings in all. Fall River, Massachusetts, with only 120,000 population has nearly 14,000.

The Quarterly

Vol. 17 **July, 1923** **No. 1**

Twenty-Seventh Annual Meeting. Chicago's welcome, after our three years' absence, was true to form. We were greeted the second day by a lively snow storm, which stimulated the memories of the older members who recalled the Chicago May meeting at which the heat was so stifling that we sat coatless through the sessions. Chicago never does anything half-way.

The Drake Hotel is commodious and comfortable and the ballroom, in spite of its size, served very well for our purpose, not being bad at all to speak in. The visit to Underwriters' Laboratories, always a feature of our Chicago meetings, was as interesting as usual and all the visitors who registered were presented by President W. H. Merrill with a copy, just off the press, of the handsomely printed and illustrated book by H. C. Brearley, "A Symbol of Safety," being a history of the development and character of this unique institution for public service.

* * * * *

The Committee Reports. The majority of the technical committees brought in either progress reports or regulations for tentative adoption and in consequence the range of the discussions of technical subjects was not quite so wide as usual. Tentative adoption was voted of proposed regulations governing Fire Department Hose Connections for Sprinkler and Standpipe systems, Steam Turbines Driving Centrifugal Fire Pumps, Prevention of Dust Explosions in Flour and Feed Mills, Installation and use of Grinding and Pulverizing Systems for Cocoa, Installation and Use of Grinding and Pulverizing Systems for Sugar, Installation of Pulverized Fuel Systems, Storage and Handling of Combustible Fibres, Construction of Dwelling Houses, Electrical Installations on Shipboard and Hazardous Commodities on Shipboard—a rather long list of practically new subjects.

Final adoption was voted of amendments to the regulations governing Automatic Sprinklers, Installation of Containers for Storing and Handling Flammable Liquids, Organization, Drilling and Equipment of Private Fire Brigades, Fire Pumps, Marine Fire Hazards and the School and Department Store Exits Codes.

At the request of the Committees themselves the proposed regulations on Prevention of Dust Explosions in Terminal Grain Elevators, prepared

picture there is no direct contact of flame.

by the Committee on Dust Explosion Hazards, and those governing the Installation, Maintenance and Use of Emergency Gas Shut-off Valves prepared by the Committee on Gases, were put over for a year.

The reports which evoked the most animated discussions were those of the Committees on Inflammable Liquids, Safety to Life and Private Fire Supplies from Public Mains, and the remarks upon the topics presented by these committees make very interesting reading in the just-published *Proceedings*.

* * * * *

The Architects' Responsibilities. Fire protection engineers are rather prone to assert that the architect does not meet his proper responsibilities to his client when he plans a building without due consideration of its fire resistive elements, and that the client has every reason to complain when he finds his architect might have saved him a fixed charge for fire insurance by slight structural changes that would in no wise have taken from the beauty of the edifice. This old idea of a conflict between beauty and fire safety with which we are all so familiar, but which is being somewhat modified in these days by an increasing assumption of responsibility on the part of the architects, appeared recently in Boston under a slightly different aspect—that of beauty versus strength.

It was a new bridge project that started a discussion of the relation between the professions of architect and engineer. The average person who gives a thought to the subject would probably say that for designing a dwelling an architect with normal understanding of structure would be a safe guide, but that for the structural problems of a skyscraper an engineer's services would be the prior need.

Yet one might be conscious of a difficulty even when proceeding so far, for it is obvious that a skyscraper, if it is to have any pretensions to esthetic distinction, must be conceived as a unit. The Wrigley building, which we all so spontaneously admired in Chicago, is as much the embodiment of artistic design as of engineering laws; it is, indeed, even more so, for the laws relate to loads and stresses and can impart only strength and security to the building, while the architect's free use of his materials in dependence upon those laws has resulted in a positive creation of beauty.

With this in mind there seems to be warrant in two contentions of an architect that in the Boston bridge project both the esthetic and the physical aspects of the structure should be considered at the very beginning; esthetic requirement cannot be treated as an afterthought.

The architect says:

> These very important problems have been carried to the point of working drawings by engineers only, and then it has been assumed that by the addition of ridiculously ineffective ornaments the work becomes beautiful.

Over against this rather tart statement of the case for beauty is the point of view of the treasurer of an engineering company who writes as unmistakably from his own viewpoint as the architect does. He comes, it will be observed, to much the same conclusion as the architect without, however, settling the issue of priority. He says:

> It will make no difference whether a firm of engineers or architects is engaged to draw the plans for the bridge across the basin, for in either case it will be an architect who approves the general lines and proportions to assure beauty of form, and it will be an engineer who determines the size and adequacy of all vital elements in the structure and its foundation.

In the case of strength as in our own case of fire safety we unhesitatingly affirm that there need be no conflict between engineer and architect. The engineer naturally tends to think of his work as mainly utilitarian, the architect of his as mainly esthetic. Both in reality are servants of practical requirements that they do not impose. A skyscraper must respect the conditions imposed by site, its rooms must have definite purposes, building height restrictions must be observed. Similarly, in a highway bridge, the size will be determined by the public authorities who are intrusted with its construction. The private dwelling must suit the owner's whims and the apartment house must conform to the building code. The engineer masters intricate physical forces at someone else's bidding and his success is an intellectual achievement no less than the architect's. They are both engaged in discovering and applying laws which the untrained mind recognizes in a general way in their applications, but which it cannot analyze.

* * * * *

Boston Steps Backward.

In an age when everything seems to be moving some people may think it better to take a step backward than to take no step at all. Of such people Boston has doubtless won the approval. Boston's building height limit has been raised from 125 to 155 feet. Many covetous landlords have desired for some years to upset the regulations under which Boston has developed beauty of facade and made such gains in the distribution of its fire resistive buildings as are indicated in member Charles E. Worthington's article on Factors Affecting the Fire Tax Rate appearing in the QUARTERLY, April, 1923. The occasion and excuse for the recent successful overthrow of the restriction which has for so many years reflected such credit upon Boston, was the proposal of the Statler Hotel Company to give Boston another hotel. They couldn't make it pay, they said, at present building heights. Propaganda began and the Governor was convinced. His special commission made the desired recommendation and the legislature was amiable. The men who fought so valiantly to establish the 125-foot limit a quarter of a century ago, when it wasn't needed half so much as it is needed today, are either dead or out of politics. The special commission appointed by Governor Cox to revise the measure as originally passed by the Legislature reported in less than two weeks, suggesting a number of minor changes. This was rapid action on a matter which many desired to have investigated in more leisurely fashion. It does not appear whether all the members and their advisers agreed on all points. But the commission's report stated that "there are comparatively few streets in the down-town business section of Boston wide enough to permit the erection of a building at the street line to the height of 155 feet under the limitations proposed." The commission felt that the new height limit would not be detrimental to the city as a whole and that "it would

in certain cases permit a more profitable development of property handicapped by the existing law."

And now that the famous victory is won the Statlers allow that the cost of building is pretty high and that they guess they won't build the new hotel just now, anyhow.

* * * * *

Four-inch Sprinkler Connections

The Racine, Wis., Engineering Club, an organization of professional engineers, acting upon a request from the local Chamber of Commerce, has appointed a committee to investigate conditions arising from a policy maintained by the local water company of restricting the size of water works' connections to sprinkler systems to four inches. The N. F. P. A. Committee on Private Fire Supplies from Public Mains, whose report was such an interesting feature of our last annual meeting, now has this topic under consideration and hopes to include in its report next year cases of actual fires to demonstrate the need of great caution in restricting fire flow by limiting pipe sizes. A few cities appreciating the difficulty of obtaining a control of possible water waste which would be absolutely certain under any conditions, have sought to decrease the hazard of loss of this kind by limiting the size of the pipe in some cases to as small as four inches, and some of these are now merely following an old custom established many years ago before the science of fire protection was well developed. The matter of water waste through bleeding the system at the time of fire has been the subject of study by the water works engineers for many years and is one of the important topics still under consideration by the committees of the American Water Works Association and the National Fire Protection Association.

Mr. Harry A. Burnham, chairman of our committee on this subject, reports that in order to obtain a general view of the prevailing water works practice, the inspection department of the Associated Factory Mutual Fire Insurance Companies in the latter part of 1922, made inquiries of the water departments serving its members as to the size of connections, charges for fire service, use of meters, etc. This inquiry was sent to 259 cities and towns in nineteen states and is summarized as follows:

The question relating to size of connections was answered by 239, of which 181, or 76%, were municipally owned, and 58, or 24%, were privately owned water works.

Of the 239 who replied to this question:	Municipal	Private
9 made definite restrictions to 4 in. size	6	3
99 allowed connections up to 6 in.	76	23
54 allowed connections up to 8 in.	39	15
10 allowed connections up to 10 in.	8	2
6 allowed connections up to 12 in.	4	2

34 made no restrictions

13 allow connections from 50% to 100% of capacity of main

Those not included in the above list made indefinite replies, indicating a general policy of treating each question as a special case.

This survey of general practice and the lack of unfavorable experiences in the use of the larger connections where properly controlled, indicates a very general recognition of the value of private fire protection systems and the need of giving them an adequate supply of water.

In looking over the reports of water works committees on this subject, there appears not to have been much progress made in fixing a standard of practice and this is not surprising as this in many cases is a complicated engineering problem. The fundamental point, of course, is to bring about the use of water in the way that will most surely extinguish the fire, prevent the destruction of property and the possible spread to conflagration extent with great community loss.

A 50% limit such as was suggested in the report of the American Water Works Association of 1919, would not always accomplish this, for if there were no limit to the number of connections within a given distance along the main it would still be possible to have an aggregate capacity of connections many times the capacity of the pipe, and if a number of such connections were used to feed into a single fire system of considerable size as in some large factories, the multiplicity of connections would result in more delay in shutting off a break than if fewer and larger connections were used. In some cases this limit would not safeguard the general water system as expected, and in others it would restrict the flow unnecessarily with no benefit to the system as a whole, with possibly serious detriment to the particular property needing the protection. For example, if the main is very long so the friction loss is large and the amount of water it can discharge at good pressure is comparatively small, short connections based on the 50% limit, might still be able to carry into the fire system even more water than the main could supply. On the other hand, if the main were short, the friction loss negligible, and the pressure low, the 50% limit would result in holding back a very considerable flow, otherwise available for the sprinkler system.

Such a limit would have to be used with great discretion. For best results, general reliance must apparently still be placed on proper means of control and a good system of handling such means of control in an emergency. Thus far it has been found extremely difficult, if not impossible, to find anything which will satisfactorily replace intelligent human control.

Meetings of Executive Committee.

May 7, 1923.

The usual session of the executives the night before the annual meeting was held at Chicago on the evening of May 7th, 1923. The following members were present:

Albert T. Bell, Atlantic City, Chairman
J. I. Banash, Chicago
George W. Booth, New York
H. L. Miner, Wilmington, Del.
F. B. Quackenboss, Nashville
Benjamin Richards, Chicago
A. M. Schoen, Atlanta
Richard E. Schmidt, Chicago
H. V. Thayer, Boston
Louis Wiederhold, Jr., Philadelphia
H. O. Lacount, Boston, President
Dana Pierce, New York, Vice-President
F. J. T. Stewart, New York, Past-President
Franklin H. Wentworth, Boston, Secretary-Treasurer

Chairman C. L. Scofield and member J. H. Brumbaugh of the Committee on Automatic Sprinklers were present as guests.

Business Transacted.

The report of the Chairman of the Executive Committee was read and approved.

The report of the Treasurer was read and approved.

The Terminal Elevator Grain Merchants' Association was elected to membership.

A committee on Protection of Records was created with the following members, the roster to be subsequently completed: H. P. Weaver, Chairman; R. K. Porter, F. J. T. Stewart, R. E. Wilson.

The following committee appointments were made:

(a) Automatic Sprinklers: Emil Schuenemann, Chicago, Chief Engineer, Western Factory Insurance Association.

(b) Dust Explosion Hazards: G. F. Ewe, Minneapolis, Terminal Elevator Grain Merchants' Association.

A. R. Small of Chicago, Vice-President Underwriters' Laboratories, was selected as the representative of the Association upon the Committee on "Fire Tests for Materials and Construction" of the American Engineering Standards Committee for which the Fire Protection Group has accepted joint sponsorship with the American Society for Testing Materials and U. S. Bureau of Standards. It was voted to recommend Mr. Small's appointment as the representative of the group.

It was voted inexpedient for the Association to undertake the conduct of the proposed tests to determine the adequacy of present regulations governing pipe sizes and spacing of sprinkler heads, and it was recom-

mended that the Committee on Automatic Sprinklers, through its subcommittee having this matter in hand, place before the National Board of Fire Underwriters and the National Automatic Sprinkler Association for consideration its arguments respecting the necessity for or desirability of such tests and its recommendations respecting the conduct of the same.

The matter of the employment of an Electrical Field Secretary under the direction of the Association through a proposed committee on Electrical Field Practice was favorably considered and the Secretary-Treasurer of the Association was authorized in co-operation with the Chairman of the Electrical Committee to investigate the possibilities of financing the same through special subscriptions by organization members of the Association who may be interested in promoting uniformity of electrical practice.

June 19, 1923.

The meeting of the executives following the annual meeting of the Association was held in New York City on June, 19th, for consideration of matters referred to the Committee by the Association, for revising the rosters of the various committees where necessary, and for consideration of reports, finances, communications, etc. The following members were present:

A. T. Bell, Atlantic City, Chairman
W. F. Ballinger, Philadelphia
George W. Booth, New York
W. S. Boyd, Chicago
F. B. Quackenboss, Nashville
A. M. Schoen, Atlanta
W. F. Steffens, New York
H. V. Thayer, Boston
H. O. Lacount, Boston, President
Rudolph P. Miller, New York, Vice-President
Dana Pierce, New York, Vice-President
W. E. Mallalieu, New York, Past-President
F. T. J. Stewart, New York, Past-President
Franklin H. Wentworth, Secretary-Treasurer.

Business Transacted.

It was voted to hold the 28th annual meeting of the Association, May 13, 14 and 15, 1924, at Atlantic City. A Program Committee, consisting of the President, Secretary and Chairman of the Executive Committee was appointed.

W. S. Boyd of Chicago and Newman T. Miller of Indianapolis were appointed to complete the Nominating Committee, 1924.

Items from Annual Meeting.

(a) The resolution submitted by the Committee on Automatic Sprinklers respecting the desired limitation of the application of the term "Sprinkler Systems" was discussed and referred back to the Committee for further consideration.

(b) The Committee on Inflammable Liquids reported further consideration of the items referred back to that Committee by the Associa-

tion at the 27th annual meeting, and acting upon its recommendations the Executive Committee adopted the following amendments to the text of the Regulations governing the installation of Containers for Storing and Handling Flammable Liquids:

Class E, General Storage, *Section 35 is amended to read as follows:*

35. Capacity and Location of Tanks. (a) The relation between the capacity of individual tanks and the permissible distances from adjoining property which may be built upon and other tanks shall be as follows:

The distance from adjoining property which may be built upon shall be for Classes 1 and 2 liquids, including crude oil, two tank diameters from shell to adjoining property, but in no case shall a distance exceeding 175 ft. be required.

For Class 3 liquids with a flash point below 150° F., closed cup, the distance from shell to adjoining property shall be 1½ tank diameters, but in no case shall a distance exceeding 150 ft. be required.

For Class 3 liquids with a flash point of 150° F. and above, closed cup, the distance from shell to adjoining property shall be 1¼ tank diameters, but in no case shall a distance in excess of 125 ft. be required.

The distance from tanks to adjacent tanks shall conform to the following table:

Minimum Distances.

Capacity of Tank Gallons	To Any Other Tank
300 or less	3 feet
500 " "	3 "
1,000 " "	3 "
8,000 " "	3 "
12,000 " "	3 "
18,000 " "	3 "
24,000 " "	5 "
30,000 " "	10 "
48,000 " "	10 "
75,000 " "	13 "
100,000 " "	15 "
150,000 " "	One tank diameter
250,000 " "	" " "
500,000 " "	" " "
1,000,000 " "	" " "
2,500,000 " "	" " "

Sections (b) and (c) are eliminated. Sections (d) and (e) are re-designated as (b) and (c).

Article 39, Embankments and Dikes, *Section (a) is amended to read as follows:*

In locations where above-ground tanks are liable in case of breakage or overflow to endanger surrounding property, each tank shall be protected by an embankment or dike. Embankments or dikes shall be made of clay-core cinder-fill; earthwork; masonry or approved concrete. Such dikes, when constructed of clay-core cinder-fill or earthwork, shall have a capacity one and one half times that of the tank, and if constructed of masonry or approved concrete may have a capacity equivalent to but not less than that of the tank. Earthwork embankments shall be firmly and compactly built of good earth from which stones, vegetable matter, etc., have been removed, and shall have a flat section at the top of not less than three (3) feet and a slope of at least 1½ to 1 on both sides. Small tanks with capacities of not over 25,000 gallons each may be grouped and a dike built around the group of tanks.

The remaining sections of Article 39 are not changed.

In accordance with Mr. Small's recommendation that the fourth paragraph in the introduction of "Regulations for the Installation of Containers for Storing and Handling Flammable Liquids" be edited, the following revised wording is adopted:

These regulations cover the general principles to be adopted when installing future equipment of this kind. Installations not fully conforming with these regulations may be submitted to the inspection department having jurisdiction, and if deemed to afford the same measure of safety may be accepted.

It was voted that the date upon which technical committee reports shall be in the hands of the Secretary in order to secure presentation at the annual meeting of the Association be advanced from April 1st to March 15th.

The following organizations were elected to membership:

(a) International Association of Municipal Electricians.

(b) West Virginia Fire Underwriters' Association.

The appointment of George W. Will as Chairman of the Executive Committee of New York Chapter was confirmed.

It was voted that the proposition to create a new membership division of professional fire protection engineers be presented to the Association for discussion at the next annual meeting.

The Budget presented by the Treasurer for the fiscal year 1923-1924 was approved.

It was voted to request the members of the Association who are graduates from technical schools and colleges to investigate and report the status of fire prevention education in such institutions.

Recommendations from Committee Chairmen for revisions of the rosters of their Committees were considered and the approved changes will appear in the forthcoming Year Book.

A Successful Society Event.

Society Editor Puts Local Color into Story of Fire.

A fire occurred in an English provincial town and caused much excitement. No member of his regular staff of reporters being available at the time, the news editor of the local paper sent the newly engaged society editor to investigate the matter and report.

The following description was handed into the office some hours later:

A brilliant fire was held yesterday afternoon at the house of Mr. and Mrs. Sniff in Dash Street. A large number of persons were present. Mrs. Sniff, who had recently had her hair bobbed, made a charming escape in a pretty silk blouse, a pattern of which appeared in our woman's page last week. The firemen were becomingly garbed in blue, full cut tunics. The weather was delightful for an affair of this kind. Because of the fire, Mrs. Jones, of 336 Dash Street, opened her home to Mrs. Sniff and her two charming daughters. The expression was heard on all sides that the fire was a most successful event. It must have cost at least £5,000.

—*Pittsburgh Chronicle-Telegraph.*

The South Carolina School Fire.

By A. M. Schoen.

The little district of Cleveland, Kershaw County, South Carolina, will not be found on the map—it is merely a cross roads settlement some six miles southeast of Camden, but suddenly the name of this district has stood forth in newspaper headlines throughout the length and breadth of the land as the scene of a calamity such as fortunately seldom has to be chronicled in the pages of our daily press.

As the evening falls, parents and relatives from all the countryside about, afoot and on horseback, in automobiles and in buggies, assemble at the district school house, bringing with them children that can walk and babies in arms—a joyous throng come to witness the triumph of its boys and girls in the play they are to give at commencement exercises. One moment a hall filled to capacity with happy neighbors and friends; twenty minutes later, a heap of smoking ruins and seventy-seven charred and smoking corpses. Will America ever learn its lesson? The holocaust of children in the school fire at Collinwood, Ohio, the inferno of the Iroquois Theatre fire at Chicago, the tragedy of the General Slocum steamship disaster at New York, and now the horror of the Cleveland District School Fire in Kershaw County, South Carolina. These are all outstanding instances of heavy mortality through fire in comparatively recent years. Each would seem to have been sufficient in itself, and yet such is the resilience of the American nature that we can forget almost before the sound of weeping has died in our ears.

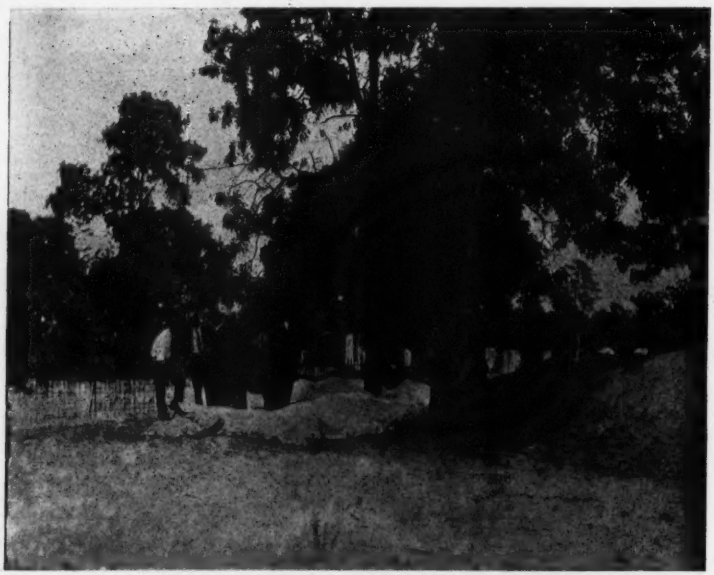
On the evening of May the 17th, while a play was being presented by the children as part of the commencement exercises, fire broke out in the district school auditorium and in twenty minutes only the smoking ruins remained and seventy-seven had perished in the flames.

Immediately following this catastrophe, I could not persuade myself to intrude on the grief of the people for the purpose of securing full details of what had happened, but on May the 26th, I had the good fortune to visit the scene in company with the Hon. John J. McMahan, Insurance Commissioner of South Carolina, and to assist him in making a full investigation. I am indebted to Mr. McMahan for much of the perfectly reliable data which I was able to secure only through his good offices. We interviewed Miss Stevens, the principal, and Misses Prosser and Garvin, teachers, all of whom barely escaped with their lives; also among those who escaped from the building, Mr. John McLeod, a trustee, and Mr. R. A. Bruce, active in the rescue work; Deputy Sheriff McLeod, one of the first to arrive on the scene; Mr. Murchison, County Superintendent of Education, and many others having contact with the affair, in one capacity or another. Those who had gone through the terrible experience were still dazed and most reluctant to talk, but out of the data gathered,

All that was left of the school building. A searching party is looking for bodies.

we were able to deduce very clearly just what had happened and to obtain many tragic sidelights.

The school house, which stood entirely unexposed on all sides, was a two-story frame building with tin roof and ceiled with wood on the inside. The building was 100 feet long by 34 feet wide, with two class-rooms and two cloak rooms on the first floor and the auditorium on the second floor, the latter being used also as a class room during school hours. These rooms were used by three teachers who taught a rural grade school from first to tenth grade. At one end of the auditorium a wooden platform had been raised eighteen inches above the floor to serve as a stage. Against the left hand wall of the building facing the stage, was a wooden stairway leading from the cloak room on that side and opening into the auditorium at a point about half way from the end of the building. This stairway was completely boarded up on either side from the cloak room to the second floor; the well hole opening to the stair shaft was protected at the second floor on one side by a hand rail about three feet above the floor and the space between the hand rail and the floor was boarded up to prevent pupils falling from that side into the stair well. At a point between 24 and 30 inches above the cloak room floor, the stairs from the auditorium, fourteen or fifteen steps in number, and having a width variously estimated at from 30 to 36 inches, came to an end on a landing three feet in width, but instead of continuing their full width to the landing, a door frame intervened at this point, thus creating an off-set on each side of the stairs, and this proved the most fatal defect in the



Bodies wrapped for burial and near the grave.

construction. From the landing, three more steps led down to the cloak room floor. From this point, a person descending would turn at right angles to the left and pass out of the cloak room door into the vestibule of the school and another right angle turn to the right led through the main door into the open.

The school was lighted by metal lamps of the Argand burner type, suspended by their bails from hooks in the ceiling. The first floor of the building was raised on brick piers to a distance of about 24 inches above the ground; the ceilings of the ground floor were about eleven feet high, and allowing 2½ feet for the height of window sills above the floor in the auditorium, it appears that the total distance from the sills of the auditorium windows to the ground was approximately fifteen feet.

On the evening set for commencement exercises, the auditorium was filled to capacity by relatives and friends of the children from a large part of the country, the number of those present being between two and three hundred. The stage had been curtained off at each side with burlap to form dressing rooms and a metal oil lamp was suspended from a hook set in the ceiling above the stage to furnish light. While the play was in progress, one of the audience, a Mr. Humphreys, observed that the wood ceiling just above the lamp had ignited and was burning. Cautioning the lady beside whom he was sitting to make no outcry, he started toward the stage to extinguish the fire before anyone else should notice it and start a panic. Before he could reach the stage, however, the hook from which the lamp was suspended pulled out and the lamp fell to the stage. Some of the men attempted to extinguish the burning oil with a rug and

Bodies wrapped in sheets awaiting burial. There were insufficient coffins available and the bodies could not be kept until shipment of coffins could be made from other points.

with the curtains on the stage, which they tore from their fastenings, but the fire spread too rapidly for them to get it under control, quickly igniting some of the curtains and flashing across the stage. A panic quickly followed and the maddened crowd rushed wildly for the one small stair. Some got through to the open before the jam occurred at the doorway opening from the stairs to the cloakroom landing, which jam had been largely due to parents dropping their children over the auditorium rail on to the stairway below. Added to this, many of those who had escaped in the first blind rush, came to a realization that they had left behind them members of their families to perish in the flames and attempted to force their way back into the building up this same narrow stairway to save them. The result was two opposite streams of humanity trying to force their way over a stairway all too small at the best, and the ensuing jam became unbreakable. The bodies were so interlaced at the doorway that three strong men from the outside seizing the living while yet in a standing position were unable to budge them and they were left in full consciousness of their fate, to perish in the advancing flames.

Many deeds of heroism and self-sacrifice were performed and more than one man gave his life that others might live. Among these, Tom B. Humphreys raised the principal, Miss Stevens, in his arms, forcing her over the heads of those packed immovably on the stairway so that she was taken through the space above the mass of bodies at the entrance, but Mr. Humphreys died in the hospital from his burns. R. A. Bruce and

The grave for sixty or more of the victims. This grave measured ten feet by forty feet. Most of the bodies were buried in this common grave as they could not be identified.

Donno Campbell passed a number of the women out of the windows to the roof over the porch and cloak room, after which they broke off the flag pole on this roof and using it, enabled the women to slide to the ground in safety. When rescuers tried to get Mr. Charles Humphreys and Mr. West out of the jam at the cloak room landing, they told them it was useless trying to save them, they were too tightly wedged, but to try to get some of those further back. Many jumped from the windows to the ground below, resulting in a number of injuries to limbs and backs. Automobiles were driven under the windows and a number were gotten safely out of the building by leaping from the windows to the tops of these.

The net result of this terrible holocaust was seventy-seven dead, of which several bodies were completely consumed and others were so badly burned that only two were recognizable by their appearance after the fire. The greater number died from suffocation before the flames reached them, but some of those who perished could only wait in full consciousness until the flames should reach them and end their agony. Two entire families were wiped out of existence,—one a widower with three girls and one little boy, and the other consisting of father, mother and one child. One lady in Camden was said to be related to 43 of those that died and there was barely a family in the town of Camden not affected.

The potential cause of this fire was, as is so frequently the case, carelessness—an oil lamp having sufficient burner capacity to throw off

through the chimney heated gases, as the products of combustion, of considerable intensity, and this lamp suspended from a metal hook set into a wood ceiling without suitable protection. Naturally after the wood above the lamp chimney had been subjected to this heat for a sufficient length of time, the fibres became charred and the weight of the lamp was such as to pull out the hook. What followed, was to have been expected.

A single exit, and it of a thoroughly combustible nature, for buildings of more than one story in height is too palpably wrong to even admit of comment, especially when such stairway is the means of egress and exit to and from a room where any considerable number of people congregate, but in this case, the most grievous mistake lay in constructing a doorway at the point where these stairs opened on to the cloakroom landing, thus creating an offset on either side. One of the fundamental recommendations in connection with exit facilities is that the stairs shall be continued full width to the street or other open space where safety is to be found.

These two items constituted the potential and the indirect cause of the heavy loss of life in the fire.

As in so many other like cases, the psychology of the crowd showed itself here. The first wild cry of fear, the first mad rush for safety, the "sauve qui peut," and then in the open, the reaction and the backward flow of the tide as those who had escaped remembered those left behind and in their thought of those others acted as blindly in their unselfishness as they had previously done in following their first natural instinct of self-preservation. Leaders there were, but it all happened too quickly for them to assert themselves and the jam having once been established the leaders were helpless, some succeeding only in dying among those they had vainly tried to save.

The story is told, but tragedy is written in the faces of many of those who saw fathers and mothers, sisters and brothers, go to their death while they stood by in helpless agony. Young hearts have been made old, and sleeping or waking, for long years the horror of this thing they have seen and lived through will cast a shadow on their lives and their future happiness will be tinged with a vague and indefinable sorrow.

Two Best Means of Curtailing Our Fire Waste.

By J. Hastings Howland,

Engineer, National Board of Fire Underwriters.
(Member N. F. P. A.)

Year by year we are coming to a more truthful understanding and appraisal of the great benefits to be derived from effectively curtailing our fire waste, a waste that is mounting to such figures that, in view of the havoc wrought and the utter futility of it all, we wonder that it can continue without causing economic disaster and disrupting our civilization itself. This very perceptible growth of an enlightened national conscience leads us to encourage the building up of preventive measures which will effect that greatest possible diminution in the loss of life and property values from fire.

Features Contributing to Our Greatest Losses.

Reports of fires involving great loss of life and large property damage show, in the great majority of cases, that they occur in buildings having open stairways or elevator shafts and without automatic sprinklers.

Consider, for example, such fires as the Collinwood and Peabody Parochial Schools, Asch Building, Binghamton Clothing and Diamond Candy Co.'s, Windsor and Lexington Hotels and the Grey Nunnery, which exacted an aggregate toll of 539 lives, and we find in nearly every case, that the fatalities were due to open stairways or other unenclosed floor openings, becoming involved and cutting off means of egress. If we look into the accounts of fires in which there was loss of life, as given in recent numbers of the QUARTERLY, we arrive at a similar conclusion. As large areas in building construction are recognized as outstanding features in the probability of fires spreading and of involving adjoining buildings, it follows that unprotected vertical openings, which unite the several connecting floors into one fire area, are unquestionably the greatest factor contributing to the spread of fire within and without a building, and therefore constitute one of the most, if not the most, serious causes responsible for our greatest losses. The value of stair towers and elevators in standard enclosures, both as means of egress and in facilitating the extinguishment of fire, was strikingly evidenced in the Burlington Building, Chicago, in which the stairs and elevators were in continuous use while the contents of the upper floors were being totally destroyed by fire.

Effect of Automatic Sprinklers.

The value of automatic sprinklers in curtailing fire waste, is receiving wider and wider recognition, due to the exceptionally small

losses experienced where such protection has been provided. An analysis of the available data, though far short of complete, is sufficiently convincing to substantiate what has been stated many times before, that the automatic sprinkler is the best known extinguishing device and is the only one that has definite value in reducing the life hazard to a minimum.

The N. F. P. A. records, which extend over a period of more than twenty-five years, show that close to 96 per cent. of the reported fires in sprinklered factories and plants of all occupancies, were held in check by the operation of the sprinkler heads. A summary of analyses made and presented in the N. F. P. A. QUARTERLIES, of 9,445 fires in mercantile establishments, apartments, clubs, hotels and twelve different classes of occupancy in highly hazardous manufacturing plants, shows that of 4,533 reported fires in sprinklered properties, 88 per cent. were small lossess, but of 4,912 fires in unsprinklered properties 68 per cent. were large losses. Of a total of 3,851 large loss fires, this summary indicates that over 86 per cent. of them occurred in unsprinklered properties. In these analyses the individual fire was in most cases designated as a large loss when the reported damage exceeded $1,000.

From reports submitted to the Actuarial Bureau of the National Board of Fire Underwriters covering a period of four years on fires in sprinklered and unsprinklered miscellaneous mercantile risks, it is shown that the losses in the first classification were only 4½ per cent of the latter with approximately the same total values involved in each.

It has been argued that loss of life may occur in buildings equipped with sprinklers, in spite of the fact that there has not been one fatality due to the usual circumstances incident to fire, in the forty years since the automatic sprinkler was first introduced. It has been estimated that a total of some 200 or perhaps 250 lives have been sacrificed by fire in sprinklered buildings, but these were very largely due to immediate exposure to high explosives and inflammables, and not because of the usual spread of fire which was prevented by the operation of the sprinklers in practically all cases.

In view of so perfect a record of service and efficiency, we must concede that the automatic sprinkler is the best protective device and extinguishing agent that has ever been devised.

Recognition of the Remedy.

As indicated by the reports issued by the Committee on Fire Prevention and Engineering Standards on more than 340 cities of over 20,000 population, the National Board of Fire Underwriters has recognized for many years that protected vertical openings and automatic sprinklers were of paramount importance in consideration of the potential hazard of the high value districts. In practically everyone of these reports the following recommendations appear under the heading "Conflagration Hazard":

"That owners of existing defectively constructed buildings, which are so located as to form conflagration areas, be required to protect floor and party wall openings, and exposed windows.

"That automatic sprinkler equipments, with outside siamese hose connections and controlling valve near main in street, be required in

all buildings, which, by reason of their size, construction or occupancy, singly or combined, might act as conflagration breeders."

These recommendations are usually marked with a star and are set in bold type, as they are deemed of most importance and their early adoption is urged. Experience shows that much progress has been made in bringing about extensive and frequently very costly improvements in our water supplies, fire departments, fire alarm systems and building laws insofar as they apply to new buildings, but comparatively little has been gained in preventing the rapid spread of fire in existing buildings of inferior construction.

There has been strong and unfortunately very effective opposition to the enforcement of the retroactive features involved in legislation necessary to comply with the above mentioned recommendations.

Interference with Remedial Measures not Justified.

It is very largely because of this opposition and our indifference in overcoming it, that, in spite of the best fire fighting facilities on the face of the globe, of the utter futility of this enormous waste which has been so strongly emphasized through the press, and of the broader education and increased activities in fire prevention, we continue to experience higher and higher losses. The aggregate property losses for 1921 and 1922 exceed by more than 32 per cent the combined figures for any other two-year period heretofore recorded, and by more than 140 per cent those of 1911 and 1912.

Our leading papers and periodicals are printing volumes on the effects of fires and fire losses and are continually harping on carelessness as our greatest evil. This all helps in educating the public, but the quickest and most effective means of cutting down the appalling life and property losses is to keep fires within narrow confines. In the opinion of many of our foremost engineers, rating experts and fire chiefs, this may best be accomplished through the general enforcement of legislation making it mandatory to protect vertical openings and install automatic sprinklers in all existing buildings where the fire hazards are particularly marked.

Occupancies Demanding First Attention.

Something over 60 per cent. of the total insured burnable values are in dwellings, yet the estimated losses in dwellings constitute less than one-tenth of our total fire loss. This would indicate that we must look to other occupancies for effecting the greatest reduction in losses. Our total fire loss would experience a very large shrinkage if all properties showed a similar loss ratio to that of dwellings.

It is the prevailing type of building that makes up the principal mercantile or congested value districts in our municipalities, known as the "miscellaneous mercantile," which contributes the largest percentage of the total fire loss, in spite of the fact that in dwellings there are many times the values involved.

Existing Laws and Ordinances Regarding Automat'c Sprinklers.

A summary of the findings in the latest reports issued by the National Board of Fire Underwriters, on practically all U. S. cities of over 20,000 population, shows that there are no specific laws or ordinances with reference to the installation of automatic sprinklers in forty-two of our states and in 200 of these larger municipalities.

Of the state laws, those in Pennsylvania and Wisconsin are the most comprehensive, in that they both require the installation of sprinklers in places of public assembly, mercantile and manufacturing buildings and in particularly hazardous occupancies.

The ordinances in more than 100 of our cities contain various regulations as regards sprinkler protection, but with little uniformity in the occupancies specified or in defining the duties and methods of enforcement. About three-fourths of the cities which have such regulations make it mandatory to provide sprinklers in specified parts of theatres, and approximately one-fourth provide such protection in basements and subbasements of buildings having stipulated occupancies. Buildings of mercantile and manufacturing occupancies or which by reason of their size, construction or occupancy, would act as conflagration breeders are required to have sprinklers in about thirty cities. A few cities require such protection in most places of public assembly and in buildings housing a large number of occupants.

The great majority of these existing ordinances are mandatory though approximately one-fourth of them have unsatisfactory discretionary features. They are about equally divided in their application to existing buildings and to new or altered buildings.

Good results have been obtained in a number of cities where there are well defined laws and specific power or duty of enforcement is properly delegated. Experience has shown that where the laws and ordinances contain indefinite retroactive features or enforcing powers left to the discretion of public officials, little has been accomplished in the way of enforcement.

While these existing laws and ordinances have not on the whole produced the desired results, they indicate a broad recognition of the benefits to be derived from sprinkler protection.

Recent Effort in the Right Direction.

Immediately following the Bastable Building fire in Syracuse, N. Y., last February, which resulted in loss of life, many serious injuries and the total destruction of the building and contents, the mayor appointed a citizens' committee to investigate and report. The building burned was of ordinary non-fireproof construction, six stories in height, of office, miscellaneous mercantile and theatre occupancy, with large unprotected vertical openings and without sprinkler protection. The fire spread rapidly and soon got beyond the control of a strong and efficient fire department, which narrowly averted a conflagration.

The investigating committee recommended that the city council pass an ordinance, requiring all existing buildings of non-fire-resistive construction having areas and heights in excess of the limits prescribed for new buildings in the present building laws, to be equipped throughout with an approved system of automatic sprinklers, or to have all vertical openings protected in an approved manner and have approved fire walls installed to reduce the areas to within the allowable limits. The property owners have thus far succeeded in postponing a final hearing before the city council.

There has recently been quite a perceptible awakening of interest in other parts of the country, which indicates that these two preventive

measures are gaining generous and most encouraging public support.

Supreme Court Decisions.

In June, 1919—City of Chicago vs. Washingtonian Home—the Municipal Court found the defendant guilty of violating the 1912 fire prevention ordinance, arising out of its failure to equip its buildings with an approved system of automatic sprinklers. An appeal to recover penalty for such violation was made to the Supreme Court of Illinois, which court affirmed the judgment of the municipal court. The following conclusion was embodied in this decision: "Any regulation which tends to lessen the damage and dangers of fires and prevent the spreading thereof in densely populated cities, is one which tends toward the protection of life and property of the public, and is therefore, unless oppressive and unreasonable, a proper exercise of police power."

The Supreme Court of Massachusetts in November, 1922, rendered a verdict of not guilty in the case of Commonwealth vs. Badger, to the charge of failure to equip building with sprinklers in violation of the law. The sustained exceptions were: "Statute confers no authority upon the fire marshal to make any delegation of power or duty—to vest discretion in public officer often held void—notice vague and indefinite without affording by reference any guide—type and manner of automatic sprinkler installation cannot be made wholly subject to the untrammelled discretion of the Building Commissioner."

In its decision this Court, however, said: "The statute is not open to objection on constitutional grounds. It plainly is a regulation designed to protect persons working upon inflammable material in rooms higher than the second story from peril of fire. It is obviously enacted in the interest of public health and public safety. It is confined in its operation to providing safety appliances for buildings above a certain height and for occupations regarded by the General Court as subjecting those engaged therein to peculiar risk from fire." The verdict of "not guilty" was based on the ruling that the notice served by the state fire marshal upon the defendant was not in conformity with the statute.

From these cases it is apparent that well defined laws and ordinances which so effectively safeguard life and property damage against fire, constitute a proper exercise of regulatory power, justifying more general legislation and enforcement.

Conclusion.

The call of our nation and of the world today is Prevention, and this annual sacrifice, of thousands of human lives and upwards of half a billion of dollars in property values by fire, must no longer be permitted.

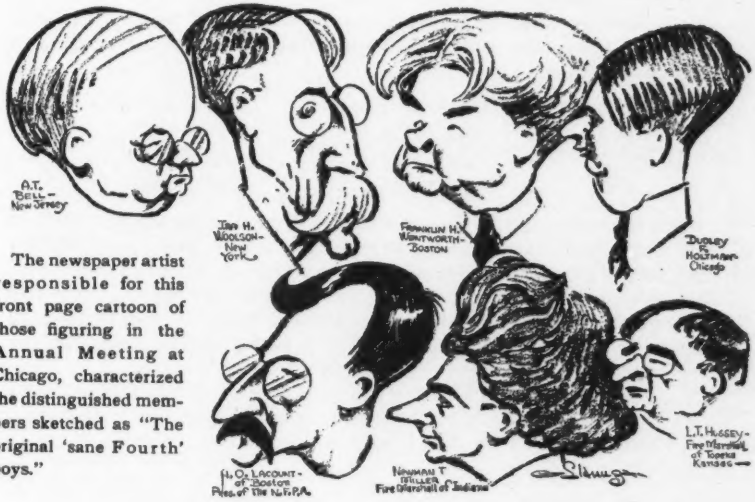
The business men, through the Chambers of Commerce, the Rotary, Kiwanis, Exchange and Lions Clubs and kindred organizations, cannot undertake a more constructive work in public welfare, than that of bringing about the general adoption and enforcement of the necessary legislation, making it mandatory to protect floor openings and install automatic sprinklers in all buildings, which by reason of their size, construction or occupancy are a menace to life and property values.

It is firmly believed that the business men are in a position to guide the bark of fire prevention through the besetting storms to a permanent

mooring in a safer and saner harbor. Once these two preventive measures are made generally effective, there will immediately follow a very perceptible reduction in our fire waste, such that the sacrifice in human lives and the cost of fire insurance, will be but a mere fraction of what they are at present.

Fire Prevention Enthusiasts

As Sketched in Twenty-seventh Annual Convention by Llanuza of the "Chicago Herald and Examiner."


A.T. BELL - New Jersey
JAS H. WOOLSON - New York
FRANKLIN H. WENTWORTH - Boston
DUDLEY E. HOLTZMAN - Chicago
H. O. LACOUNT - of Boston Pres. of the N.F.P.A.
NEWMAN T. MILLER Fire Marshall of Indiana
L.T. HUGGEY - Fire Marshall of Topeka Kansas

The newspaper artist responsible for this front page cartoon of those figuring in the Annual Meeting at Chicago, characterized the distinguished members sketched as "The original 'sane Fourth' boys."

The Fire Loss in 1922.

The current report of the Committee on Statistics and Origin of Fires of the National Board of Fire Underwriters gives the estimated fire loss in the United States for 1922 as $521,860,000. This is a per capita loss of $4.75. The fire loss and the per capita loss for 1922 surpass any fire loss figures yet recorded, even exceeding the loss in 1906, the year of the San Francisco conflagration. No large conflagrations occurred during 1922, but the reports bear evidence that there were more fires last year than in any preceding year.

As a striking contrast to the losses in the United States, the Committee presents the three-year record for Great Britain, as compared with the United States:

Year	*Great Britain*	*United States*
1920	$42,445,000	$447,886,677
1921	38,820,000	495,406,012
1922	30,812,000	521,860,000

From the best information obtainable, the population of Great Britain in 1922 was approximately forty-three million people, and the population of the United States for the same year was about one hundred and eleven million. The per capita loss in Great Britain last year was 72 cents and that of our own country for the same year was $4.75. These figures are interesting as showing a continuing decrease in the British loss, while the reverse is apparent with respect to losses in the United States.

A list of the cities in which the loss in 1922 exceeded $5.00 per capita follows. Similar data for 1917-1921, inclusive, appeared in the July, 1922, QUARTERLY (Vol. 16, No. 1, p. 16).

Peoria, Ill.	$24.84	*Nashville, Tenn.	$9.88
Atchinson, Kansas	23.90	*Pine Bluff, Ark.	9.71
*Fort Dodge, Iowa	20.49	*Terre Haute, Ind.	9.64
Bethlehem, Pa.	17.31	Norwood, Ohio	9.36
Peabody, Mass.	14.25	*Portland, Maine	9.24
Jamestown, N. Y.	14.04	‡Kansas City, Mo.	9.17
†Charlotte, N. C.	13.65	*Hutchinson, Kans.	9.08
†Concord, N. H.	13.37	*Waterloo, Iowa	8.97
Winona, Minn.	13.28	*Eau Claire, Wis.	8.75
*New Orleans, La.	13.03	*Nashua, N. H.	8.73
Portsmouth, Va.	12.38	Elmira, N. Y.	7.78
‡Memphis, Tenn.	11.97	Raleigh, N. C.	7.61
**Norfolk, Va.	11.47	Pueblo, Colo.	7.53
*Council Bluffs, Iowa	11.07	Alton, Ill.	7.52
÷Dallas, Texas	10 65	*Olean, N. Y.	7.50
**Fresno, Cal.	10.54	Muskogee, Okla.	7.00
Lynchburg, Va.	10.03	*Gloversville, N. Y.	6.89
Troy, N. Y.	9.93	Stockton, Cal.	6.84

*Cumberland, Md.	$6.75	Cambridge, Mass.	$5.74
Passaic, N. J.	6.53	*Columbia, S. C.	5.72
Durham, N. C.	6.49	Woonsocket, R. I.	5.65
†Haverhill, Mass.	6.46	*Baltimore, Md.	5.52
*Danbury, Conn.	6.42	Glens Falls, N. Y.	5.50
*Oshkosh, Wis.	6.41	†Wichita Falls, Texas	5.49
Lewiston, Maine	6.31	*Port Huron, Mich.	5.46
*Fort Worth, Texas	6.28	Waco, Texas	5.43
South Bend. Ind.	6.22	Norristown, Pa.	5.35
Davenport, Iowa	6.22	Battle Creek, Mich.	5.34
Paterson, N. J.	6.17	Portland, Ore.	5.31
‡Hoboken, N. J.	6.14	†Atlanta, Ga.	5.27
Wilmington, N. C.	6.06	†Stamford, Conn.	5.20
†Tampa, Fla.	5.85	‡Chelsea, Mass.	5.20
*Pontiac, Mich.	5.83	†Meridian, Miss.	5.18
Shreveport, La.	5.81		

* These cities in this class in two of the last five years.
† In this class three of the five years.
‡ In this class four of the five years.
** In this class five years.

Liability in Canada for Preventable Fires.

The May issue of the *Dominion Fire Chief* tells the story of a fire in Port Coquitlam, B. C., and its aftermath of litigation which is especially interesting because it records the decision of Canada's highest court that one who causes damage to another by reason of negligence in causing fire is liable for damages to the sufferer under the common law.

Another point of interest is that in this especial case the town itself, through the negligence of its employees, is the culprit.

The Municipal Authorities of Port Coquitlam in preparing rooms for the man serving as Chief of Police and Fire Chief had employed a local plumber to install a stove pipe (which they had paid for) to a kitchen stove, the property of the chief. The pipe passed through a wooden ceiling, thence through an attic and out of the building through a shingle roof.

Sometime before the fire occurred the stove had been removed by the Chief and another one substituted and one of the sections of the pipe was shortened in such a manner as added to the risk of fire. The fire it was admitted originated in the fire hall from the stove in question and it was claimed to have been by the negligence of the Town, its servants, or agents and so spreading therefrom as to destroy the property of each of the parties to the action.

Particular attention is directed at this point to the fact that under a municipal by-law duly and properly enacted the pipe should be "enclosed in brick or tile walls with a space of at least three inches between the enclosing walls and the smoke pipe."

It was submitted at the trial of the first action that there was non-compliance with this by-law and that compliance with it would have prevented the escape of fire.

The case was first tried with a jury who rendered a verdict in favor of the Town. On appeal to the British Columbia Court of Appeal this verdict was set aside and a new trial ordered.

The second trial was held, also tried with a jury who rendered a verdict for the plaintiffs, the damages to be determined by the Registrar of the Court.

Leave was given by the B. C. Court of Appeal to the Town to appeal direct to the Supreme Court of Canada and the arguments were heard in the closing months of 1922. The finding of the Court, concurred in by five judges, and dissented from by one judge was that the municipality was liable on the ground that they were responsible for the setting of the stove in the first place by their servant whose duty it was to take notice of anything calculated to make the use of it a source of danger.

It was further held that in view of the existence of its own by-law, and of the fact that the fire would not have occurred if the by-law had been complied with they were *prima facie* liable for not having taken reasonable means to prevent harm to the neighbors by the escape of the fire.

The written judgment of Justice Duff is a remarkable one inasmuch as he traces back from earliest times the responsibility of the occupier of a building or other premises for damage caused by a fire lighted there and escaping, in the course of which he brings out the amending statute of 14 Geo. C 27, s. 86 by which it was provided:

"No action, suit or process whatever, shall be had, maintained or prosecuted against any person in whose house, chamber, stable, barn or other building, or on whose estate any fire shall . . . accidentally begin."

While Justice Duff states there are points still unsettled as to the effect of this statute, on principle, since it creates an exception to the general rule, the onus ought to be upon the defendant to show that the fire did accidentally begin. He, however, did not think it necessary to pass upon the point for purpose of the appeal, but adds "the effect of the statute is to impose upon the occupier of the premises, the duty to take all reasonable precautions to prevent the fire getting beyond his own premises and doing injury to others." It may be added that he found an obligation to compensate a person suffering damage as the result of the escape of a fire intentionally lighted by their servant in the stove. Following is an extract from the Court's opinion:

> On the assumption that the relevant fire is the fire that started in the attic, the question was this, was this fire ignited by matter escaping from the stove through the negligence of the municipality, that is to say, through the negligence of somebody for whom the municipality is responsible? Now the fire was put in the stove by or by permission of the servant of the municipality who was occupying the premises for the municipality who was aware of the *ex hypothesi* negligent setting up of the pipes which had taken place some time before. As between the municipality and the caretaker, the caretaker was no doubt guilty of a grave dereliction of duty on this hypothesis in lighting a fire in circumstances which exposed the building to the risk of being burned, but he was nevertheless about the municipality's business and for the negligent conduct of that business it is responsible.

The town of Port Coquitlam will have claims to settle under this decision variously estimated at from $40,000 to $75,000.

The interesting group of pictures shown above were produced by the New Mexico Insurance Department (Member N. F. P. A.) in co-operation with the U. S. Forest Service in connection with the United States Forest Fire Prevention Campaign during the latter part of April. These pictures in attractive colors are hung in the leading hotels along the transcontinental highways passing through New Mexico. A title plate hung over the pictures bears the inscription, "A Tragedy of the Forest in three chapters."

Progress in Fire Prevention Education.

A Survey of its status in the U.S. Public Schools.

The recent passage of the Whitcomb bill in New York State providing for compulsory fire prevention education in New York schools has been of interest as an important step in the development of fire prevention education, and calls attention to the very material progress in enactment of legislation of this kind within the past few years. That within the past four years ten states have enacted laws requiring fire prevention instruction in schools is an encouraging accomplishment in carrying out the program of fire prevention education long advocated by the National Fire Protection Association.

Shortly after the passage of a fire prevention instruction law in New Jersey in 1920, the National Association of Credit Men (Member N. F. P. A.) introduced a bill, modeled on the New Jersey law, in forty states. The Fire Marshals' Association of North America, the National Board of Fire Underwriters and other members of the National Fire Protection Association heartily co-operated in this campaign. While it was not entirely successful, it did a great deal of good in calling the attention of the various boards of education in the several states to the importance of this work. The New Jersey law is reprinted in full later in this article.

Another beneficial movement has been the distribution of hundreds of thousands of copies of Safeguarding the Home Against Fire, the fire prevention manual for school children prepared by the National Board of Fire Underwriters and officially recommended by the United States Bureau of Education and the National Fire Protection Association.

A survey of the present status of fire prevention education in the various states conducted by the N. F. P. A. Executive Office discloses some interesting information on a variety of methods in use in the teaching of fire prevention in the schools of the United States.

Thirteen states now have legislation in force requiring fire prevention education. Four other states have developed methods of introducing the subject into the schools generally. The following summary will show the main characteristics of the law as operative in the thirteen states.

State	Enforcing Authorities	Time Required for the Subject	Date Law Went into Effect
California	Board of Education	None stated	1921
Iowa	State Fire Marshal	Four times a year	1913
Kentucky	Board of Education	Once a week	1921
Nebraska	Fire Commissioner and Superintendent of Instruction	Thirty minutes a month	1913
New Jersey	Insurance Commissioner and Commissioner of Education	One hour a month	1920
New York	Commissioner of Education	Fifteen minutes a week	1923
North Carolina	Insurance Commissioner and Superintendent of Public Instruction	None stated	1915

State	Enforcing Authorities	Time Required for the Subject	Date Law Went into Effect
Ohio	Fire Marshal and Superintendent of Schools	Fifteen minutes a week	1921
Pennsylvania	State Police and Superintendent of Public Instruction	None stated	1919
Rhode Island	Commissioner of Education	One hour a month	1919
South Carolina	Board of Education	None stated	1923
West Virginia	Superintendent of Schools	None stated	1921
Wisconsin	Industrial Commission and Superintendent of Schools	Thirty minutes a month	1921

As is readily noted there is no uniform method of placing the authority for carrying out the provisions of the law and the time devoted to the subject varies considerably. Practically all of these laws have been put in force only during the past few years, several as a result of the 1921 campaign, and none of them have been on the statute books for more than ten years.

Fire Prevention Week has been quite generally observed in all the schools throughout the country. While the value of this observance is unquestionable, much of the benefit obtained from it is lost if no attempt is made to follow up the lessons learned at that time with regular instruction at periodic intervals.

The brief summary of activities in the various states given below may be of interest in indicating the trend of the movement. Some of the more comprehensive laws are given in full that they may serve as a guide for other states.

California.

A state law, approved May 12, 1921, provides that the board of education, or high school board, of each county and city shall prescribe a course of study in fire prevention dealing with the protection of lives and property against loss and damage as a result of preventable fire. The aims of the course are stated in the law as follows: (1) To create an understanding of the cause and origin of fires; (2) to emphasize the dangers of carelessness and neglect in homes and public buildings and the necessity of care in the use of fires; (3) to promote an interest in preventing fires and the protection of lives and property.

A reasonable time must be devoted to the subject in each school month. Fire prevention study is also required in the normal schools of the state. A forest fire prevention manual prepared by the State Forester is in use and Safeguarding the Home Against Fire is also used.

Iowa.

A part of the State Fire Marshal law of Iowa (1913) reads as follows: "The state fire marshal shall prepare a bulletin upon the causes and dangers of fires arranged in not less than four divisions or chapters, and under the direction of the executive council shall publish and deliver the same to the public schools throughout the state and the teachers thereof shall be required to instruct their pupils in at least one lesson each quarter of the school year with reference to the causes and dangers of fires."

In accordance with this law the State Fire Marshal prepares and sends out bulletins for use in the schools. The Fire Marshal's depart-

ment also sends out lecturers to the schools and assists in promoting Fire Prevention Week observances in the schools.

Kansas.

While there is no law requiring fire prevention education in Kansas, the State Fire Marshal has been successful in introducing this work in many of the schools. Bulletins and instructions to teachers are furnished and the children are instructed in how to extinguish small fires and in the common hazards in the homes.

Kentucky.

The statutes provide that fire prevention shall be taught in all public and private schools of the state at least once each week. Copies of Safeguarding the Home Against Fire have been distributed to the schools by the Department of Fire Prevention and Rates. The inspectors of this department give fire prevention talks to the school children.

Nebraska.

It is provided by state law (1913) that a manual for the purpose of instruction in fire dangers and in methods of fire prevention shall be prepared by the chief deputy fire commissioner and the state superintendent of public instruction and copies provided for every teacher in the public, private, or parochial schools in the state. Every teacher must devote not less than thirty minutes in each school month to fire prevention instruction.

New Jersey.

The New Jersey law, dated September 1, 1920, is the one that has been considered a model and is reproduced below in full.

"An Act to compel instruction in the public, private and parochial schools of this state in fire prevention and safeguarding lives and property against loss by fire.

"1. The Commissioner of Banking and Insurance and the Commissioner of Education are hereby empowered and directed jointly to provide a course of study in fire prevention for use in the public, private and parochial schools of this state dealing with the protection of lives and property against loss or damage as a result of preventable fire.

"2. It shall be the duty of the board of education, school directors, trustees or other committees or persons having control of the public, private or parochial schools in each township, village, borough or city or school district thereof to arrange for said course of study in fire prevention and to compel its use in each school under its or their control or direction.

"3. On and after September 1, 1920, it shall be the duty of each teacher in any public, private or parochial school of the State of New Jersey to devote not less than one hour in each month, during which such school is in session, to the instruction of the pupils thereof in said course of study in fire prevention comprising the ways and means of preventing loss and damage to lives and property through preventable fires.

"4. This act shall take effect immediately."

Safeguarding the Home Against Fire is used as a text.

New Mexico.

Attempts have been made to introduce fire prevention education as part of the curriculum of the schools of this state but so far no action has been taken by the school authorities. A pamphlet on Fire Prevention and Forest Protection in New Mexico has been prepared for the New Mexico Department of Education by the United States Forest Service and has been sent to all teachers in the state by the State Insurance Department.

New York.

An act has recently passed to take effect September 1, 1923. The act reads as follows:

"The commissioner of education is hereby directed to provide and prescribe a course of instruction in fire prevention relating to the protection of life and property against loss or damage as a result of preventable fire, for use in the schools of the state.

"The board of education, trustees, principal or other person in charge of every public, private and parochial school in the state shall arrange for giving such course of instruction in every school under its or his control or direction. Such instruction shall be given to all of the pupils in every such school for a period of not less than fifteen minutes in each week during which such school is in session."

North Carolina.

The North Carolina state law provides that "it is the duty of the Insurance Commissioner and the Superintendent of Public Instruction, as far as practicable, to provide for the teaching of Fire Prevention in the colleges and schools of the state."

The State Insurance Department has six ladies in its employ who specialize in fire prevention education work. The Department has issued a considerable amount of literature and bulletins for use in the schools. The Insurance Commissioner advises that excellent results are being obtained.

Ohio

The state law of Ohio reads as follows:

"Sec. 12901. The state fire marshal and the superintendent of public schools are hereby empowered and directed jointly to provide a course of study in fire prevention for use in the public, private and parochial schools of the state, dealing with the protection of lives and property against loss or damage as a result of preventable fire. It shall be the duty of each board of education or the board or persons in control of such schools to compel the use of such a course of study in each school under their control. Whoever, being a teacher or instructor in a public, private, or parochial school, wilfully neglects to devote at least fifteen minutes in each week during which such school is in session to instructing the pupils thereof as to the dangers of fire, shall be guilty of a misdemeanor and fined not less than five dollars nor more than twenty dollars.

"Sec. 12902. On and after September 1, 1921, it shall be the duty of each teacher in the public, private, or parochial schools in the state to use such course of study in fire prevention in the classes under his control. There shall be placed in the hands of each teacher above mentioned,

prior to September 1, 1921, by the superintendent of public instruction, through the county superintendent of schools, a book for the purpose of the instruction of pupils. Such book shall be conveniently arranged in a sufficient number of chapters or lessons to provide a different one thereof for each week of the maximum school year."

In accordance with this law a text book entitled "Dangers and Chemistry of Fire" has been prepared for use in primary schools and grammar schools.

Pennsylvania.

A statute enacted July 1, 1919, provides that, "It shall be the duty of the Department of State Police to prepare, in consultation with the Superintendent of Public Instruction, books for instruction, for use in the public and private schools, of students of all grades, with regard to the dangers of fire and the prevention of fire waste." This statute also provides that the curriculum of the schools shall include "some regular and continuous study of such subjects during the entire school year." Fire prevention instruction is included in the civics course for the elementary grades. There is no text book on fire prevention used.

Rhode Island.

The public laws of Rhode Island provide that the Commissioner of Education shall "prescribe a course of study in fire prevention for use in the public schools of the state, dealing with the protection of lives and property against loss and damage as a result of preventable fires." Not less than one hour in each school month must be devoted to fire prevention education. In 1919, an edition of 30,000 copies of Safeguarding the Home Against Fire was published and distributed to municipal school departments. The Commissioner of Education has also had prepared a short course of study in Fire Prevention which has been distributed to all the schools.

South Dakota.

While there is no law requiring fire prevention education, the State Fire Marshal provides bulletins and booklets on fire prevention to the schools of the state free of charge. The State Fire Marshal has also succeeded in having the committee that revised the state course of study for the common schools include in several years of the language work data on fire prevention. Good results have been obtained by this method.

South Carolina.

A bill has just been enacted by the General Assembly (March, 1923) which reads as follows:

Section 1. The State Board of Education shall provide for instruction in fire prevention in the elementary public schools of the state.

Section 2. Each teacher in any public school of this state shall give such instruction in fire prevention as may be prescribed by the State Board of Education.

The plan for fire prevention instruction has not yet been fully worked out and a text book has not yet been adopted.

Texas.

The Texas State Fire Insurance Commission allows a three per cent

key rate credit for the teaching of Fire Prevention in the public schools under the direction and supervision of the Commission. The following rules must be complied with to obtain the credit:

In the third and fifth grades one period each week, of from fifteen to thirty minutes, must be given to the study of Fire Prevention. This period must be named "Fire Prevention" on the daily program. The book which may be used is either "The Flame Fiend" or "Safeguarding the Home Against Fire." In the third grade this book shall be in the hands of the teacher; in the fifth grade it shall be in the hands of the pupils.

In the sixth and seventh grades, one theme each term must be written on Fire Prevention.

In the High School, one theme each term must be written on Fire Prevention.

The work in the third and fifth grades, aside from the use of the above named book, or books, may consist of written or oral stories along Fire Prevention lines; the discussion and reports of large conflagrations, both State and National; the discussion and reports of fire hazards, and particularly local hazards and conditions. "Uncle Jim, the Fire Chief," an adopted State Textbook in the Supplementary Course of the Intermediate Grades, might well be used in this course.

The work in the sixth and seventh grades of one theme each term should consist of the study of the large conflagrations; a study of the child's own home and its hazards; a study of the protection against and the removal of his own home hazards; a study of similar school conditions; a study of the modern means of fire protection; a study of the ways of turning in a fire alarm.

The work in the High School of one theme each term should consist of the study of the great conflagrations of history; a study of the fire department of the city; a study of fire hazards in the student's own home and school; a study of the best use for civic progress to which the preventable fire waste might be applied; a study of the progress of Fire Prevention in the past ten years.

The theme work in the High School and the sixth and seventh grades might well be done during the months of October and April or other convenient months, but the very important matter of theme writing should not be overlooked.

The Commission has just completed its second year's work along this line and there are now approximately two hundred and fifty towns and cities in Texas teaching this course in the schools. The results have been very satisfactory.

The Commission has two lady traveling representatives who devote all their time to school and other educational work.

West Virginia.

The state school law of West Virginia (1921) contains a section which reads as follows:

"Section 1. The state superintendent of schools is hereby empowered and directed to provide a course of study in fire prevention for use in the public, private, and parochial schools of this state, dealing with the protection of lives and property against loss or damage as a result of preventable fires.

"Section 2. It shall be the duty of the county superintendent, board of education, directors, trustees or other committees or persons having control of public, private and parochial schools in each county, village, city or school district, to arrange for such course of study in fire prevention and to compel its use in each school under its or their control or direction."

The State Fire Marshal purchased fifty thousand copies of Safeguarding the Home Against Fire and three copies were distributed to each teacher in the state.

Wisconsin.

The State Department of Public Instruction has recently prepared a bulletin on Accident and Fire Prevention. The Department is awaiting the appropriation of state funds for the publication of this course of study for state wide distribution. Sufficient copies for use in Milwaukee County have been printed and distributed by the Milwaukee Association of Commerce.

The Wisconsin state law (1921) requires the Industrial Commission to submit to the State Superintendent of Schools an outline of fire prevention education to form the basis of the study of fire prevention in the schools. A minimum of thirty minutes in each month must be devoted to the subject. The plan is to incorporate this work with other subjects such as English, civics, history, etc., rather than to set apart a separate course in fire prevention.

Other States.

None of the other states, so far as is known, have any law requiring fire prevention education or any state wide system of introducing this subject into the schools.

Through the state fire marshal or the department of public instruction large quantities of Safeguarding the Home Against Fire are being used in the states of Indiana, Michigan, and Minnesota, so that it is clear that fire prevention is being taught in at least some cities of these states. State fire prevention officials have attempted to introduce a state law on fire prevention education in Minnesota and in Massachusetts but so far without success. Similar unsuccessful attempts have undoubtedly been made in other states.

In several cities, in states having no law requiring fire prevention education, this work has been introduced by action of municipal officials. In a number of cities such as Chicago, St. Paul, Seattle, Richmond, and New Britain, fire prevention is introduced through other school courses or is combined with a general course in safety education. The following few instances are illustrative of some of the methods adopted in cities in states having no general law.

Oklahoma City.

Through co-operation of the school superintendent with the fire chief and the state fire marshal, talks are given in all the schools and each teacher is provided with a copy of the manual furnished by the state fire marshal's department along with other literature of a similar nature.

Fire prevention is taught in connection with science, citizenship and other courses. A fire prevention essay contest for all the schools was held last year and Fire Prevention Week was observed with special talks and exercises.

Kansas City.

A course of study has been developed by the Kansas City Safety Council which includes fire prevention education. A manual of instruction has been prepared and copies placed in the hands of all teachers. All of the children in the elementary schools are given inspection blanks for locating fire hazards in their homes. This plan has proven very successful, twenty-four thousand of the blanks being filled out in the last campaign.

Detroit.

Fire prevention is made a part of the curriculum in every grade of the elementary schools. The instruction begins in the kindergarten with information dealing with "children and matches" and bonfires, and is developed in each grade to suit the ability of the children. By the time the pupils finish the eighth grade they are familiar with the common hazards of the home and the ways of preventing fires and also what to do in case of fire.

The Fire Department sends men into all the schools to talk on fire prevention and a special apparatus to show how to turn in a fire alarm is used.

Canton, Ohio.

A rather unique method of fire prevention education was developed by the fire chief of this city. An elaborate exhibit of fire hazards was prepared in the fire headquarters and the principals of each school were invited to bring their classes. On the arrival of a class, the chief gave a lecture and explained the various features of the exhibit. All the school children in the city received the benefit of the lesson.

Curb Pumps Ruled Out in Buffalo.

Motor fuel discharge devices located at the street curb were the subject of a special resolution adopted by the Executive Committee, N. F. P. A., in June, 1922, which reads as follows:

It is the opinion of the National Fire Protection Association as expressed by its Executive Committee that where motor vehicles are to be supplied with liquid fuel in the street a fixed pump at the curb is the safest and most efficient means of delivering such supply, and the Association from the standpoint of the fire hazard favors the general installation and use of such pumps under proper supervision as to location.

It will be noted that this resolution deals merely with the item of filling operations where they are to be carried on in the street, and is intended to give the fixed curb pump a better standing as to fire hazard than the portable liquid fuel tank often used for this purpose. The virtues of the "drive-in" filling stations were not considered in this resolution, neither was the question of public policy in taking public property for private use. This latter consideration receives interesting emphasis from the recent court decision prohibiting the installation of curb pumps on city property in the State of New York. The following report of this decision, and the attendant circumstances, is extracted from the *National Petroleum News*:

What may be one of the most important court decisions in history as it affects the marketing of gasoline, was handed down June 12 by the New York State Court of Appeals, the highest court in the state. The court decided that curb pumps installed on city property, that is in the space between the building line and the curb, are illegal.

The court allowed a writ of mandamus to issue against the mayor and council of Buffalo, ordering them to remove all such pumps. While the decision of the court is of course applicable to the entire state, it will be operative only in Buffalo at present because it is only in this city that proceedings have been brought to compel the removal of the pumps. The same result would follow action in any New York municipality to abolish curb pumps.

It is estimated that the total number of pumps affected by the ordinance is between 600 and 700.

One of the complications is that due to the peculiar situation in Buffalo, the order of removal of curb pumps absolutely bars the garage, except perhaps in very few instances, as a retailer of gasoline.

Buffalo has a fire ordinance forbidding the installation of a pump in any building and the garages have overcome this difficulty by putting their pumps on the curb. The same is true of tire and accessory stores. In almost every case, the front of the building coincides with the owner's property line and there is no space for a pump on his property outside the building. This leaves such establishments with no place to put a gasoline pump.

Many of the curb pumps in Buffalo enjoy a business that probably is not approached by such installations in any other marketing territory, because of the fact that Buffalo, as well as all of New York state, has always relied on the curb pump rather than the filling station for its gasoline supply. How to retain this gallonage by diverting it to drive-in stations handling their products, is one of the problems confronting the distributors.

Another complication in the situation is the fact that there is now before the Buffalo council a zoning ordinance which, if it passes, will absolutely prohibit the installation of gasoline storage tanks either for curb pumps or filling stations within a zoned area that comprises roughly a third of the area of the city. If this ordinance is passed it will mean that oil companies will not be permitted to put in filling stations anywhere in the downtown district and in a large part of the residential district. Such an ordinance would operate as a gold mine for the companies who already have stations within the restricted district, for the terms of the ordinance as at present drawn do not provide for the removal of tanks already in place.

Another, and probably the most serious aspect of the case, is the intention of the council to rush the removal of pumps. Mayor Frank X. Schwab has signified his intention to introduce in council a resolution ordering that all pumps affected by the order must be out within 90 days. This, the oil companies maintain, is an unreasonably short time. They think they should be given at least a year to readjust their business and remove the prohibited equipment.

The origin of the suit that resulted in the court order against curb pumps is unique in that it had its source neither with the politicians nor with the automobile driving public. In fact, the city officials fought the suit because the curb pumps were a good thing for the city as revenue producers, each pump being subject to a tax of from $25 to $75 a year, according to the capacity of its storage tank, under an ordinance passed

a year ago. In the aggregate the pumps were worth some $40,000 a year to the city treasury.

The motoring public, too, seemed well satisfied with things as they were. At least, no representatives arose to start the proceedings in their behalf.

The suit, in the form of a petition for a writ of mandamus to compel the Buffalo council to remove the curb pumps, was filed in the supreme court of Erie county in the name of John Kahabka, president of the Drive-In Station Men's Association, and proprietor of a drive-in station on Fuller avenue. The suit was directed toward the removal of two curb pumps in the immediate neighborhood of his place of business.

The suit was based on the ground that the two specified pumps "were located in and upon said public streets and the sidewalks thereof by private interests for their own gain and do now exist without lawful license or authority and are unlawful encroachments and obstructions of said public streets."

On Sept. 2, 1922, Justice George E. Pierce handed down his decision in favor of the city and against Kahabka.

Judge Pierce's decision was based on the proposition first, that authority over the streets is in the hands of the legislature and that the legislature had properly delegated that power to the city. Second, that curb pumps were a public necessity. His opinion went on to say:

> The governing body of the city being met by this situation (the general use of vehicles requiring means of replenishing their gasoline supply) is compelled to determine how the automobile user can be served with the least inconvenience and danger to the traveling public both vehicular and pedestrian.
>
> The two present known ways are to have a standpipe at the curb with a tank on private property or under the surface of the street between the curb and the street line so that vehicles can stop at the curb and have their supply of fuel replenished; and the other is to have the tanks and standpipe on private property with driveways from the street leading into the tank and another driveway leading from the tank back into the street.
>
> One method involves some hindrance and inconvenience to the people using the paved or traveled portion of the street, the other method involves some inconvenience to the people using the paved or traveled portion of the street and also to those lawfully using the sidewalks or that portion of the street between the curb line and the street line.
>
> The furnishing of gasoline being a necessary incident to the use of trucks, pleasure vehicles and all kinds of conveyances propelled by the use of gasoline, the use of which is lawful and a proper street use, the city, through its governing board has the right and it is its duty to determine by proper ordinance or regulation which method shall be used or whether both methods can be used and to prescribe what safeguards shall be thrown around the use of either method.

Kahabka appealed the case to the appellate division of the supreme court, where the decision of Judge Pierce was reversed on May 2 of this year. Judge Charles B. Sears, who wrote the opinion for the appellate division, took an exactly opposite view from that expressed by the judge of the lower court, as follows:

> The gasoline tanks, while no doubt useful to many persons using the public streets, constitute a non-essential and private use, a use for the gain of the owner of the stand and not a use in a public or even quasi-public capacity. Neither in the provisions of the charter nor any other statute to which our attention has been called, have we found authority to authorize the city to divert the public streets to such private use.

The city, represented by Corporation Counsel William S. Rann, immediately appealed the case to the court of appeals which, without writing an opinion, unanimously supported the decision of the appellate division of the supreme court declaring the pumps a nuisance and granting a writ of mandamus compelling the city officials to remove them. The two pumps specified in the petition were ordered removed forthwith.

In order to understand the history of the pump suit, it is necessary to know that Buffalo streets for years have been dotted with wooden news stands maintained by the newspapers for the sale of their wares under some kind of arrangement with newsboys and of the newspapers with each other. These stands usually are placed near the curb near prominent corners on the main thoroughfares.

Last summer there was a row in the Buffalo newspaper world. There was a lively fight through the courts, ending, when the smoke had cleared away, in a decision of the court of appeals to the effect that the newsstands were a nuisance, that they were using the public streets, maintained by public taxation, for private gain.

The decision of the court in the news stand case gave the filling station proprietors an idea. If the use of the public streets for news stands was illegal, why not for gasoline pumps?

The drive-in filling station men resented keenly the fact that while they were paying taxes and other overhead expenses to maintain their stations on their own property, dealers with a site donated by the city, and pumps given to them by an oil company, were underselling them and making money.

It is likely that the companies may take into court a plea that the 90 days time allowed for removal of the pumps is too short and ask for a longer period.

Meantime, there is a feeling among the oil companies in Buffalo that the curb pump is on the wane all over the country. It is felt that with the number of automobiles constantly increasing and the traffic problem in every city constantly becoming more serious, the curb pump is becoming more and more a traffic obstruction that must give place to the drive-in station.

There will continue to be numerous curb pumps installed undoubtedly but they will not be on city property along the curb line where a car stopping for gasoline may hold up traffic for blocks behind it.

Mice Caused this Fire.

There have been so many times that mice and matches have been blamed for a fire when no other apparent cause was available that attributing fires to this cause has become unpopular and doubt is often expressed as to whether mice ever cause fires. It is, therefore, interesting to report the following instance of apparently conclusive evidence that mice caused the fire.

The photograph above, obtained through the courtesy of Mr. I. E. Peak (Member N. F. P. A.), shows the point of origin of the fire, which occurred on January 26, 1923, in a tenant manufacturing building in Everett, Mass. The fire started inside of a hollow wooden partition on the fifth floor. The photograph shows one side of the partition removed. Traces of mice nests and refuse brought in by mice were clearly visible after the fire. The building is known to be infested with mice as other hollow partitions removed after the fire disclosed mice nests similar to the one which caused the fire.

Three sprinkler heads operated and extinguished the fire shortly after it broke through the partition.

Carbon Dioxide for Coal Mine Fires.

By Charles L. Jones.

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This article comprises a description of the methods used and results obtained in fighting a coal mine fire which broke out on the night of November 16, 1922, in the Bitner Mine of the H. C. Frick Coke Co., near Greensburg, Pa. The mine is a drift mine with a considerable area of gob (refuse material) and old workings under very light and rather leaky cover, and was hence treated by the direct method until December 16, when the area included in the zone actually on fire was approximately thirteen acres. On December 16, the application of carbon dioxide was commenced, and large quantities were introduced until December 25, after which date the rate of gas input was reduced considerably. Small amounts were applied regularly until the final opening of the mine on March 26, 1923. Water was used very effectively in certain parts of the fire zone in the presence of atmospheres which would not support combustion. The expense incurred for carbon dioxide has been moderate.

The use of carbon dioxide and other inert gases for extinguishing mine fires, both in coal and metal mines, and of mined coal in storage, has been proposed many times and has been tried out sporadically. The various attempts have met with all degrees of success, from complete effectiveness to entire failure, depending upon conditions. However, the relative costs of different sources of inert gas, the amounts necessary to ensure success, and the technique of inert-gas application have never been definitely determined in such a way as to encourage conservative mining engineers to make any general application of the method, although the theoretical supremacy of inert gas as a fire-extinguishing agent has been generally taken for granted.

Successful applications of the inert-gas method as long ago as 1851, at Clackmannon, Scotland, have been related by Walker[1]. The use of liquefied carbon dioxide as a fire-extinguishing agent seems to have been first suggested by Barber[2], and Spencer[3] has described the successful application of liquefied carbon dioxide to a small mine fire. Evans[4] has told of a fire at Senghenydd colliery in the fall of 1913, which was treated for

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This article is an abridgement of a detailed report on the same subject, which accompanied by full tables of data, appeared in the June, 1923, issue of *Coal Industry*, p. 292.

[1] *Mines and Minerals.* June, 1908. 505.

[2] *American Chemist, 5* (1875), 395.

[3] *Trans. Inst. Min. Eng., 17* (1900), 181.

[4] *Colliery Guardian,* March 7, 1916, 505.

several weeks with insufficient amounts of carbon dioxide manufactured on the spot from sodium bicarbonate and sulphuric acid. Even in this case, although water and perseverance finally put out the fire, it is believed that the carbon dioxide rendered valuable assistance in damping temperature and pressure changes and breathing effect.

On the other hand, carbon dioxide has been employed unsuccessfully in several cases recorded in the literature,—for example, in the metal mines of the United Verde Copper Company[1]. However, fires in metal mines take place under vastly different conditions from those in coal mines, particularly with respect to the ratio of the amount of combustible material to its oxygen supply; and consequently the two classes of mine fires cannot be treated in at all the same manner by the inert-gas method. The compressed-air method finally adopted by the copper company mentioned would have played havoc in a coal-mine fire. It is of interest to note that the fireman at a burning building must use his judgment unaided by any accurate means of determining conditions he cannot see, while the mine fire can be literally "chemically controlled," by means of gas analysis.

Bitner Mine Fire—Starting Gas Application.

The fire referred to was discovered on the night of November 16, and is supposed to have been caused by a grounded trolley. However, from its later behavior, it seems possible that more than one source of fire may have played a part. At any rate, the fire spread notwithstanding the best efforts of the fighters, until the length of the area actually on fire was 2,400 feet, when Mr. J. R. Campbell, Chief Chemist for the Company, suggested that inert gas be considered. On December 13, it was decided to try liquefied carbon dioxide, and by the afternoon of December 16, 1,440 fifty-pound cylinders of carbon dioxide had been hauled over 60 miles by motor truck, a line of 25 brick-stoppings in the mine surrounding the fire area had been completed, some of the surface leaks caused by falls along the outcrop of the coal seam had been sealed, facilities had been provided for discharge of gas into the mine through three boreholes, and at 3:00 P. M. the first gas was discharged into the mine. Much better time might have been made, had it not been necessary to plan and construct discharge facilities on the ground.

What Is Carbon Dioxide?

Carbon dioxide, CO_2, exists in small percentages in the atmosphere. It is a product of combustion, and hence will not support combustion. It is a colorless, odorless, tasteless gas, approximately 1½ times as heavy as air. It is produced by nature through all types of combustion, decay and fermentation, and is given off in large quantities by certain volcanoes. It is non-poisonous, atmospheres containing up to 5 per cent causing no serious impairment of normal activity, and much higher percentages causing no permanent ill effects.[2] It acts on the system largely by reducing the oxygen content of the air with which it is mixed.

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[1] *Bull. Am. Inst. Min. Eng., 55* (1916), 186.

[2] Burrell, G. A. Robertson, I. W., and Oberfell, G. S., Black Damp in Mines; *U. S. Bureau of Mines, Bulletin* 105.

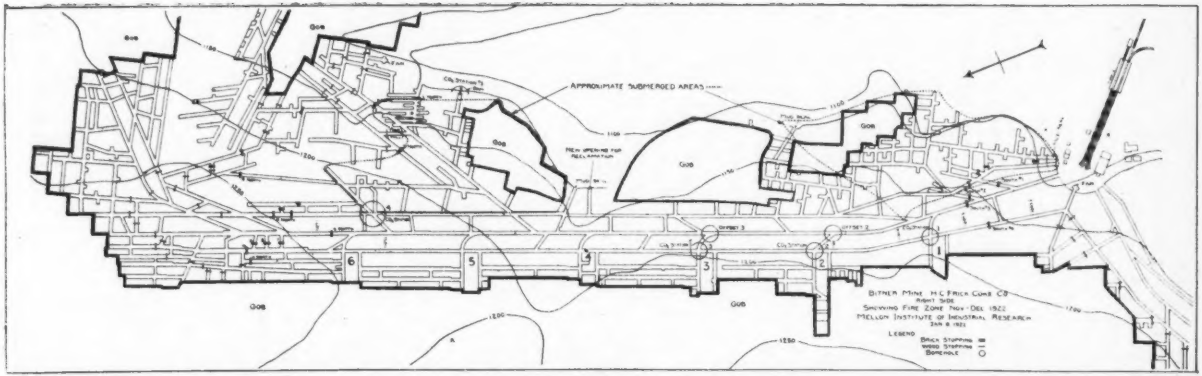

Fig. 1. Mine map showing the fire area at the Bitner Mine, H. C. Frick Coke Company. The fire broke out on November 16, 1922. On December 16, carbon dioxide was introduced. Large amounts were applied daily until December 25 and small amounts were regularly applied until March 26, 1923. The map shows the position of the brick and wood stoppings, the boreholes at which the gas was introduced, and the areas of the mine that were submerged. The mine was opened on March 26. The fire area has been explored and reclaimed, and the mine is now again in operation.

The artificial production of liquefied carbon dioxide in the United States amounts to between fifty and sixty million pounds annually. Small quantities are obtained from magnesite, from fermentation, and from natural mineral springs, but the bulk of it, over 90 per cent in fact, is manufactured by the combustion of coke. High-grade coke is burned under specially constructed boilers, with carefully regulated draft, producing flue gases with 17 to 19 per cent of CO_2. The flue gases are scrubbed to remove dirt and sulphur compounds, and the carbon dioxide is then absorbed in sodium or potassium carbonate solution, from which it is boiled out practically pure. Modern plants are balanced so that there is just enough steam produced from the combustion of the coke to operate the machinery and compress the carbon dioxide into steel cylinders.

The refrigerating effect of the gas expanding from the pressure in the cylinders deserves especial mention. When the gas is discharged direct from cylinders to the atmosphere, or into a mine, this refrigerating effect is sufficient to reduce a part of the gas to the form of a snow, which has a temperature colder than 100° F. The cooling effect of this snow in the mine is not great, as compared with the effect of the gas in excluding air from the fire, but is important nevertheless. This cooling effect is not an unmixed blessing, however, for it results in occasionally stopping up the cylinder valves with snow so as to retard the discharge of gas from the cylinders. At the Bitner fire it was, therefore, necessary to keep the valves thawed out by means of torches during the comparatively short period when it was desired to obtain very high rates of gas input. Means have since been developed of avoiding this mechanical difficulty, without recourse to torches or other sources of heat.

Carbon dioxide has been used for the extinguishing of other classes of fires, and is used rather extensively on shipboard. One branch of the Bell telephone system uses "gas" extinguishers, filled with carbon dioxide, for the extinguishing of fires in telephone switchboards.

Method Used at Bitner.

The drums were discharged into the mine through boreholes in units of five, each unit being housed separately in a temporary shelter. One of these units is shown among the accompanying photographs (Fig. 3). Previous to commencing the application of gas, seven boreholes had been drilled from the surface into the mine workings, and four of these holes were used for the introduction of gas. The casing in the boreholes was reduced to two inches at the top, and led to a manifold of two-inch pipe with one-half-inch branches. In general, the five drums of each unit were discharged all at once and changed on regular schedule, allowing from two to eight hours between changes. However, the schedules were laid out on a basis of the trend of gas analyses, pressures and temperatures in the fire zone, and on one occasion a drum was discharged completely in less than half an hour, while, on another, drums were changed only twice daily. Each of the shelters was heated by a salamander which burned coke.

Gas samples were taken through one-half-inch pipes cemented into the stoppings and through boreholes not used for gas input. Tempera-

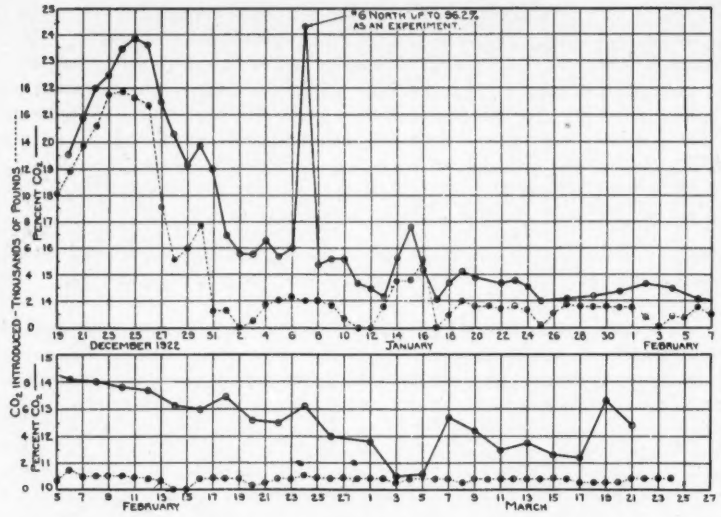

Fig. 2. The heavy line shows the percentage of carbon dioxide in the blackdamp from December 20 to March 21. The dotted line shows the amount of carbon dioxide introduced in thousands of pounds on each day.

tures were taken by means of tapered hardwood poles about four feet in length, made to enter and plug a two-inch pipe through the stopping up to the last six inches of their length. They thus protruded inside the stopping some thirty inches, and carried on the inner end a thermometer placed in a groove and fastened. These thermometers were left in position continuously, except when withdrawn for reading, and the error introduced by withdrawing them for this purpose is believed to have been small. Temperatures were also taken at the bottom of the boreholes by means of maximum-minimum recording thermometers. The locations at which these analyses and temperatures were taken may be identified on the map (Fig. 1). It will be observed that the boreholes actually used for gas input have been numbered from south to north, and that the south stoppings and the north stoppings have been numbered separately. Although the total number of brick stoppings is twenty-five, the number of effective stoppings separating fire areas from respirable gases is fifteen, four on the south end and eleven on the north. Pressures were measured only a part of the time by means of an Ellison draft gage, and were noted at other times simply as positive (outward) or negative. Where fans were ventilating the area outside the stopping, the fan pressure had to be added or substracted from the observed differential pressure, in order to get the inside pressure relative to atmospheric pressure.

Over 1,000 gas analyses were made of samples taken through the stoppings. The value of gas analysis as an indicator of conditions at the seat of the fire in this kind of work cannot be over-emphasized.

Effects of Temperature and Pressure Changes.

The rate of gas input and its effect are shown in Fig. 2. As will be seen, gas input started Saturday afternoon, December 16, and on December 24 reached the maximum rate of 355, 50-lb. cylinders of carbon dioxide in twenty-four hours, or 159,750 cubic feet. On December 26-7 the first decided cut in gas rate was made, reducing the number of cylinders approximately 50 per cent. Referring to Fig. 2, it will be noted that the percentage of carbon dioxide in the black damp * commenced to decrease at this time, and continued a "long swing" decrease throughout the rest of the work, except as brief increases were caused by lowering barometer or further changes in rate of gas input. An inspection of the volumes required to effect the changes shown in gas composition will confirm the statement that the mine is a very leaky one.

Throughout the operation, gas analysis proved to be a most useful instrument in predicting changes and in controlling the gas input. Gas analysis variations can be correlated with barometric changes consistently, and the comparatively large amount of gas taken up by the mine during the earlier stages, without producing violent outward movement of gases, can be explained only on the basis of rapid cooling. Unfortunately, the temperature records are not as complete as might be desired; but this is not felt to detract much, as temperature data obtained at stoppings must be interpreted with the utmost caution. Every temperature reading so obtained is affected by the direction of the gas movement.

Perhaps the best example of this is at South Stopping No. 4, where the gas analysis was decidedly unsatisfactory for a larger percentage of the time than at any other point. This point was particularly sensitive to barometric changes, and the tendency towards inward movement of gases at this point seemed to be greater than at the other stoppings sampled. Temperature readings at this point were always satisfactory, fluctuating somewhat with outside temperature. Several times during March it was reported that the gas analysis was such as to encourage fire in this local area, and on March 19 some increase in carbon monoxide percentage at this point was noted. When the mine was finally opened, a small hot bed of smoldering coke was discovered a short distance inside, which fortunately was so limited in extent as to be easily extinguished and loaded out. All temperatures recorded in this end of the mine were below 75°F. before opening the mine. It is therefore quite safe to say that gas analysis has proved itself capable of indicating conditions not recorded on a thermometer—at least when the thermometer is placed near a stopping and when the gas movement is inward.

A second excellent example of incorrect indications of temperature is in the increases noted at many points during December, when carbon dioxide was being introduced at the greatest rate, and when the gas analysis indicated that no fire could exist in the sealed-off area. This apparently puzzling phenomenon was caused merely by the establishment of a current of gas outward from hotter portions to the cool stoppings,

"Black damp" is the miner's term for gases which will not support combustion, mixtures of carbon dioxide and nitrogen. Percentages of carbon dioxide in the black damp, as shown in Fig. 2, instead of percentages of carbon dioxide in the entire mine atmosphere, furnish an equally definite basis of comparison, and are free from errors due to in-leakage of air (see p. 48).

due to the large amounts of gas introduced. Under certain conditions, then, rising temperatures around the edges of a sealed-off fire may be hopeful signs that the leakage is outward, while falling temperatures may indicate only inward leakage.

Breathing, thermal contraction, and other influences may change the gas analysis considerably at a given point; yet if there is no fire behind a given stopping, the percentage of air will vary without changing the proportions of nitrogen and carbon dioxide in the synthetic black damp which has been built up by adding carbon dioxide to the normal black damp. This result is modified somewhat through absorption of oxygen by the coal, but it is at least roughly true.

The direct variation of gas composition shown by analysis with barometric fluctuation is to be expected and may be traced throughout the gas analysis tables.

Effects of Gas, Water, and Sealing.

Three different agencies played parts in the extinguishing of the Bitner mine fire: gas, water and sealing. Inspection of the ground, coupled with observations of the behavior of the fire after sealing had been completed, but before gas was applied, afforded ample basis for the statement that the fire probably would never have been extinguished by sealing alone—or, at any rate, only at the very great expense of mud-sealing very thoroughly nearly one-quarter mile of falls along the outcrop of the coal seam. Also, for the considerable area never reached by water, indicated by the high-water line marked on the map (Fig. 1), it is, of course, safe to say that the fire would not have been extinguished by a combination of sealing and water treatment.

Water was, however, of the greatest assistance in rapidly cooling certain parts of the mine which could be reached by it; in fact, without water cooling, it would have been impossible to open the mine within such a reasonable time. In addition to the sections where it was possible to submerge the roof, and hence make certain of the absence of fire, other sections which could not be flooded were treated for a part of each day with running water. It should be emphasized that the main function of this running water, which did not reach the roof over the greatest part of the area affected by it, was not to extinguish fire but to produce rapid cooling, and in this action it was very successful. Water was not applied, moreover, until January 5, after gas analysis indicated that all flame had been extinguished, and when temperatures indicated that the possibility of forming large amounts of steam or water-gas, or of causing violent volume fluctuations by the introduction of water, was remote. Under these conditions cooling was much accelerated.

By building surface dams at both ends of the mine, it proved possible to back the water up inside the mine to the high-water line shown on the map. Without some such scheme, it would have been impossible to flood any considerable part of the mine.

As regards the cooling effect of the gas itself, reference has already been made to the refrigerating effect of carbon dioxide expanding from cylinders. However, the main cooling effect of the inert gas is due to the exclusion of air. If it is assumed that each pound of carbon dioxide introduced is effective in preventing an equivalent volume of air from

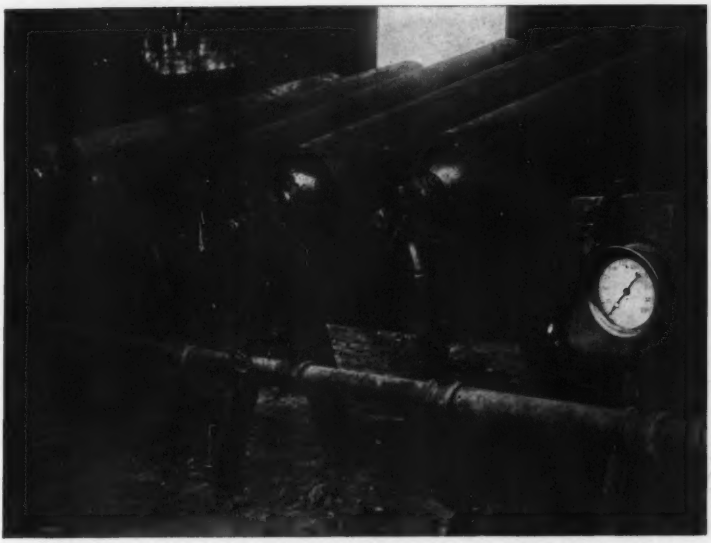

Fig. 3. A battery of carbon dioxide cylinders being discharged into the mine.

gaining access to the fire, it is found that it has prevented the generation of something like 600 B.t.u., and hence has made available this amount of cooling effect by conduction through adjoining strata, which would otherwise have been taxed to dissipate heat generated by combustion supported by inleaking air.

Present Condition of Bitner Mine.

On March 26, a new opening was broken through the coal about the middle of the fire area, as indicated on Fig. 1. Starting from this point, by the present time (June 1, 1923), the fire area has been explored and reclaimed from end to end along the main haulage, manway, and air return, and along the main gob area on the west side of the mine. Some hot coals have been found, but the hot material was confined to small areas where the gas had not been fully effective, and was such as to be wet down and loaded out without serious difficulty. It is worthy of mention that the early stopping of combustion by inert gas, combined with the slow cooling as compared to direct use of water, resulted in causing less falling of the roof.

Coal is now being produced from the reclaimed area. Smaller areas on the east side of the mine, that is, along the outcrop, have been sealed up pending the time when it will be convenient to explore and reclaim them. So far as is definitely known, there is no flame in these areas, although hot spots may exist. Exact conditions in these relatively small parts of the mine will not be known unless and until they have been explored. For obvious reasons, some worked-out parts of this area may never need to be opened.

Functions of Carbon Dioxide.

The principal function of carbon dioxide in this instance is not so much to extinguish fire *per se*, as to prevent inward leakage of air, both by compensating for fluctuations of barometric pressure and by following up the contraction due to cooling.

To illustrate the latter point, consider an underground working which is comparatively tight, and fire in which could be extinguished easily by accepted methods of sealing off. If the fire is a hot one, and occupies a considerable percentage of the sealed-off area, the average temperature in the fire zone might easily be 240°F. In such a case the contraction in cooling to normal temperature would be about 25% of the gas volume in the fire area. Assuming no leakage, this would result in a pressure difference across the brick stoppings of about 3.7 pounds per square inch, which could not be sustained by masonry, wood, or earth seals for any period of time. The fact that no such pressure is ever found in practice can only be explained on the basis of leakage equalizing pressures and indicates the importance of leakage even where it is not necessary to use inert gas. Much time might be saved by inert gas treatment of such a fire, especially where the fire area cuts off access to important live workings, and it is desirable to open the sealed-off area as soon as possible.

Liquefied Carbon Dioxide Compared with Other Inert Gases.

Other inert gases have been proposed for fighting mine fires, namely, sulphur dioxide, nitrogen, and flue gases.

Sulphur dioxide is expensive and not always available in liquid form. As a flue gas from burning sulphur on the spot, it is not of satisfactory composition, and introduces serious complications by making irrespirable the gases in the parts of the mine outside the fire area.

Nitrogen is obtained in large quantities in the manufacture of oxygen by the liquid-air process. The ratio of cylinder weight or shipping weight to the weight or volume of gas contained introduces high transportation charges, however, so that nitrogen need be considered only where the fire to be extinguished is very close to the plant shipping the nitrogen. Further, carbon dioxide is more effective than nitrogen, at least for gaseous combustion[1].

Flue gas is the only serious competitor of liquefied carbon dioxide for fighting mine fires and has been used successfully for the purpose. But flue gas is not so effective as carbon dioxide, it contains some oxygen, it is not as easily transported and distributed over large areas, and it requires for its preparation and application equipment which takes some time to assemble. The liquefied gas excels it in the following particulars:

(1). Liquefied carbon dioxide is 100 per cent. effective. Flue gas is only effective in proportion to the oxygen which has been removed from it. The preparation of flue gas containing 19 per cent. of carbon dioxide cannot be accomplished in any kind of improvised apparatus by inexperienced help, and it also requires considerable care and close regulation of draft. The availability of comparatively large amounts of water for cooling the flue gas is an additional necessity.

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[1] J. K. Clement, "The Influence of Inert Gases on Gaseous Combustion," U. S. Bureau of Mines, *Technical Paper 43*.

While flame is extinguished by moderate percentages of carbon dioxide, incandescent carbon will continue to absorb oxygen until very low percentages of residual oxygen are reached. The residual oxygen introduced with flue gases is, therefore, undesirable.

(2). Liquefied carbon dioxide is in most cases quickly available. The motor truck has placed most of the country's coal mines within a few hours of the nearest liquefied carbon dioxide plant, and a minimum of special equipment is required for the application of the gas. Flue gas application requires time and trouble for the installation of special equipment.

(3). Liquefied carbon dioxide is portable. In the Bitner mine fire, gas was introduced through six stations or units, separated by considerable distances along a line over 2,000 feet long. Once an entire station was moved to a new location where it appeared to be more effective. It would have been expensive and difficult to distribute flue gas in this manner from a centrally located boiler.

On the other hand, flue gas is unquestionably cheaper per cubic foot where it is to be used in sufficient quantities and over a long enough time to pay for the equipment that must be installed. The writer believes that flue gases and liquefied carbon dioxide have distinct and special fields, and that flue gases should be used wherever the amounts used will be large enough to pay for the necessary special equipment, and other conditions are favorable.

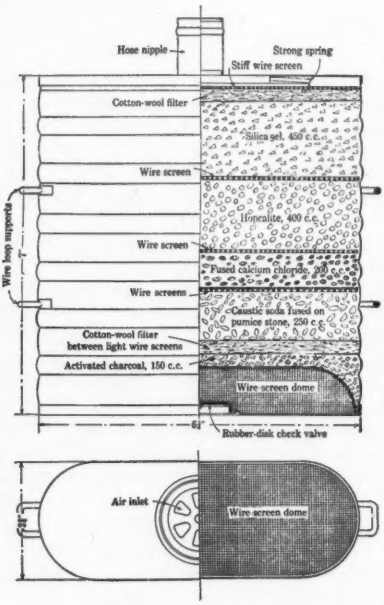
Cost of Liquefield Carbon Dioxide Application.

The amount of liquefied carbon dioxide used, and hence its cost, will depend upon the amount of leakage and the length of time during which the application of gas must be kept up. These conditions will vary, of course, for different mines.

In the case of the Bitner fire, the actual cost of the carbon dioxide gas alone is less than 10 per cent. of the total sum spent to date, the remainder being largely expense of direct method of fighting. Under average mine fire conditions, if there are any average conditions, bad mine fires probably can be extinguished with inert gas for less than 50 per cent of the cost of the direct method.

The Fireman's Gas Mask.

In the April, 1922, QUARTERLY (Volume 14, No. 4, page 369) data was given on the Bureau of Mines' investigation of the use of the army gas mask for fire fighting. It was shown that the army mask did not protect against ammonia and carbon monoxide, both of which the fireman may encounter.



The Bureau has continued its investigation and has recently issued Technical Paper 300, "The Universal and the Fireman's Gas Masks." The details of the fireman's canister are shown in the accompanying illustration. This mask is designed to protect against carbon monoxide and other gas for four hours, allowing a large factor of safety. The canister is 2⅜ in. x 6¼ in. and is 7 in. high and weighs four pounds. The complete mask weighs about 5½ pounds and is convenient to wear without interfering with the activities of the wearer. The canisters are more active when warm and should be worn under a coat in cold weather.

Absorbents Used.

Starting from the bottom of the canister, as shown in the illustration, the following absorbents are used:

1. Dry, activated charcoal absorbs organic vapors, which include alcohol, aniline, benzene, carbon bisulphide, carbon tetrachloride, ether, toluene and the like.

2. The filter of cotton wool on the charcoal filters out smoke and dust particles.

3. The caustic soda on granular pumice stone absorbs acid gases such as carbon dioxide, chlorine, formic acid, hydrogen cyanide, and sulphur dioxide and also extracts water vapor from the air, thus preventing moisture from contaminating and inhibiting the action of the hopcalite.

4. The fused calcium chloride removes any moisture that may pass the caustic pumice.

5. Hopcalite is a granular mixture of oxides of manganese, copper and possibly silver and cobalt. It acts catalytically on carbon monoxide in air, causing the monoxide to take up oxygen and change to the dioxide. The hopcalite will fail if moisture penetrates it.

6. The silica gel absorbs organic vapors and also ammonia. It also prevents moisture from reaching the hopcalite.

Limitations.

This mask is no better than any other gas mask in that it cannot guard the wearer against suffocation in atmospheres deficient in oxygen, because the canister serves only as a filter for removing comparatively small amounts of poisonous gases from air otherwise normal. The mask is not designed to remove toxic gases where the concentration of the gas is more than one or two per cent.

Use.

Gas masks of this type are now being manufactured commercially and are being sold to fire departments for fifty dollars. They are being used in the fire departments in Atlantic City, Baltimore, Boston, Cleveland, New Orleans, Philadelphia, Providence, St. Louis, Washington and elsewhere.

Sprinkler Protection for Schools.

The following list of three hundred and twenty-one school buildings in the United States and Canada which are under complete or partial automatic sprinkler protection has been compiled by Ira G. Hoagland, secretary of the National Automatic Sprinkler Association (Member N. F. P. A.). This data furnishes an interesting index of the extent to which proper fire protection equipment is being installed in our older non-fire-resistive school buildings. The list makes no distinction between partial and complete sprinkler installations, and includes only the equipments actually in service at the time the survey was made.

Location	No. of Sprinklered Schools
ARIZONA	1
CALIFORNIA:	
Los Angeles	1
CONNECTICUT:	
Middlebury	1
So. Manchester	7
Wallingford	1
Waterbury	1
FLORIDA:	
St. Petersburg	1
GEORGIA:	
Atlanta	1
Columbus	2
ILLINOIS:	
Chicago	6
Chicago Heights	1
Evanston	4
Highland Park	1
INDIANA:	
Evansville	1
Terre Haute	1
South Bend	1
IOWA:	
Des Moines	1
LOUISIANA:	
New Orleans	7

Location	No. of Sprinklered Schools
MAINE:	
Bangor	1
Lewiston	6
MARYLAND:	
Baltimore	6
MASSACHUSETTS:	
Amherst	1
Brookline	1
Boston	2
Cambridge	3
Cohassett	1
Danvers	1
Fall River	1
Groton	1
Lowell	1
Manchester	3
New Bedford	3
Newton	25
Peabody	1
Salem	14
Segreganset	1
Springfield	2
Wakefield	1
Worcester	1
MICHIGAN:	
E. Lansing	1
Flint	8
Grand Rapids	6
MINNESOTA:	
Faribault	1
Minneapolis	1
MISSISSIPPI:	
Starkville	1
MISSOURI	
Kansas City	1
NEBRASKA:	
Omaha	1
NEW HAMPSHIRE:	
Concord	1
NEW JERSEY:	
Camden	2
E. Orange	2
Jersey City	1
Passaic	1
West Orange	2
NEW YORK:	
Albany	1
Amsterdam	9
Binghamton	7
Bronxville	1
Brooklyn	1
Buffalo	4
Elmira	1
Fordham Heights	1
Ithaca	1
Jamestown	14
Little Falls	1
New York	3
Onondaigua	1
Perry	1
Poughkeepsie	1
Queens	1
Rochester	2
Seneca Falls	1
Solvay	2
Syracuse	9
Utica	1
Van Nest	1
NORTH CAROLINA:	
Morgantown	1
West Raleigh	1
OHIO:	
Bond Hill	1
Cincinnati	5
Cleveland	2
Columbus	1
Linwood	1
Winton Place	1
OREGON:	
Portland	3
PENNSYLVANIA:	
Bucks County	1
Ellsworth	1
Erie	4
Philadelphia	1
Pittsburg	69
Scarsborough	1
Sewickley	1
State College	1
Swarthmore	1
Wilkinsburg	1
QUEBEC:	
Montreal	1
RHODE ISLAND:	
Newport	1
Providence	4

Location	No. of Sprinklered Schools
SOUTH CAROLINA:	
Calhoun	1
TENNESSEE:	
Johnson City	1
Nashville	2
Sewanee	1
TEXAS:	
Bryan	1
College Station	1
WEST VIRGINIA:	
Mannington	1
WISCONSIN:	
Ashland	1
Madison	1
Superior	1

The Broad Street Station Fire.

Fire which started under the track floor of the Broad Street station train shed of the Pennsylvania Railroad at Philadelphia, just before midnight on Sunday, June 10th, wrecked the entire track floor and the huge train shed and destroyed a large amount of baggage and railway property in the story below the track floor, including the power plant, which supplied heat and power to the station building. The loss is estimated at approximately one million dollars. For a time the station proper and the adjacent City Hall were menaced but they were saved from damage. Sparks were carried across Market Street to the south of the station and set fire to wooden formwork under concrete floors of a theatre under construction. The forms were destroyed from the sixth to the thirteenth floors but damage to the construction was slight.

Construction of Train Shed.

This train shed, built thirty years ago, had one of the largest steel arch roofs in existence. It was 300 feet, 8 inches in span with a rise of 108½ feet and was 598 feet long. The arch had a heavy wooden roof laid on the outside and a composition covering.

The train level is on an elevated structure, 25 feet above the street. The baggage room, record storage rooms, mail rooms and power house were underneath the track floor. The ceilings of these rooms were constructed of extra heavy corrugated iron fastened up with 3-inch angle iron, which was clamped to the main steel supports. There was a space between this ceiling construction and the flooring above which formed one large concealed area throughout the shed. The track girders partially separated this into bays, but the manner in which the fire spread indicates that to all intents and purposes this was one continuous concealed space more than four acres in area. The construction of the train shed flooring was unusual. Heavy timbers were laid crosswise on the steel beams that run parallel with the length of the shed. On top of these were laid timbers, 8 by 10 inches and 10 by 14 inches. Across the top of the lower timbers were 2-inch planks. The platform proper was also of 2-inch planks. This construction extended over the whole area of the train shed with the exception of the gutters and between the rails, in which was an asphalt composition laid on wooden flooring.

The Broad St. station fire at Philadelphia. Unusual structural conditions made effective fighting of this fire almost impossible. The famous old City Hall, shown in the background, was fortunately unharmed.

Story of the Fire.

The testimony of employees and evidence available leads to the conclusion that the fire was caused by a lighted cigarette or cigar discarded on the platfrom. The fire was discovered at 11:40 P. M. The first indication was a small amount of smoke along the edge of the platform, but no flames were visible until several boards were lifted. The railroad fire brigade responded and a chemical engine was put into service but the smoke was so dense that it prevented effective work. Five minutes after the first sign of fire was discovered, flames were noticed on the underside of the platform over the power house and sixty feet distant from the point of discovery.

The public fire department was summoned and six alarms were subsequently sent in. Fifty-four companies and 424 men were used to fight the fire. The apparatus in service consisted of fourteen pumpers, eleven steam engines, seven aerial trucks, four pipe line wagons and one water tower. The hydrants in use were 4-inch single and double, spaced about 150 feet apart. Twelve high pressure and thirty-three engine streams were thrown. The eastern end of the fire was a block away from the western boundary line of the high pressure system so that it was impossible to get more than twelve effective streams from this service. Long lengths of hose were necessary and a total of 30,000 feet of hose was laid.

A section of the train shed roof during the progress of the fire. The wooden sheathing on this roof made possible the rapid spread of the fire.

The fire spread rapidly in the concealed spaces and communicated to all the rooms below. On reaching the side of the shed, the fire spread vertically in the concealed space between the copper and wood sheathing to the roof. Once in the roof, the spread of fire was extremely rapid due to the wooden sheathing and the unusual draft conditions.

Many passengers were asleep in Pullman cars in the shed and firemen and railway employees had to work quickly to save their lives. Some of the cars were pulled out by switching engines but this soon became impossible, and the remaining passengers were hustled out along the platforms to the station, many of them nearly suffocated by the heavy volumes of smoke, and some burned by falling brands. All of these passengers lost their entire belongings.

Early in the fire spray from a hose stream short circuited the generators and lights throughout the shed were extinguished. The steam main burst putting the railroad company's fire lines out of service.

The fire continued for over twelve hours. Firemen experienced great difficulty in reaching the fire in the concealed spaces. Gangs of workmen were set at tearing up the asphalt flooring and acetylene torches were used to cut some of the steel-work so that the concealed spaces could be reached.

Damage.

The train shed is a total loss with the exception of the wall on Market Street. The wrought iron girders and supports on which the track floor was carried are distorted and bent.

Practically all of the arches and rooms under the shed were affected. The greatest damage was to the power plant and to the baggage room. Some 800 pieces of baggage were destroyed.

Fortunately there were no lives lost in the fire. Some thirty firemen were injured or overcome by smoke during the fire.

Conclusions.

The spread of fire and its rapid envelopment of the train shed and arches underneath is attributable to:

1. Large undivided areas with resulting draft.
2. The concealed space between the platform and corrugated iron ceiling over the arches.
3. Wooden roof sheathing on the train shed.

Loss of Life in Sprinklered Fires.

The value of the automatic sprinkler as a protection against loss of life by fire has often been remarked upon by fire protection engineers. However, all such statements have necessarily been of a vague and general nature as no comprehensive statistical data has ever been previously developed on this subject.

The N. F. P. A. Committee on Safety to Life briefly reported on Sprinklers as Life Savers in 1914 and 1916. They reviewed all data available and found a total of 34 deaths in sprinklered building fires. They were able to show that in every instance the deaths came within one of the three following classes:—

1. Persons killed by an explosion or burned to death by a slight fire which usually set fire to their clothing.
2. Persons entering a building to rescue some article.
3. Firemen killed in the performance of their duties.

The Committee drew the following conclusion: "That it is to-day an almost unquestioned fact that the automatic sprinkler affords the largest degree of protection of life against fire in practically all cases where there is combustible construction or material, the rapid burning of which is liable to be a menace to the lives of the occupants of the building."

The Boston Manufacturers' Mutual Fire Insurance Company surveyed their reports for a period of forty years (1874-1913) and found that only twelve lives had been lost in sprinklered buildings. Three of these people were killed by going back into a burning building to save personal effects, and four were firemen who were killed in the performance of their duties. This record covered mills employing one and a half million people.

The Factory Insurance Association reported that in over 2000 fires in which sprinklers had operated, only one employee had lost his life, and that was due to an effort to go back into the room to obtain some belongings.

These reports, now nearly ten years old, while interesting, have not, because of their limited scope, conclusively proven the value of sprinklers as life savers. Accordingly the Department of Fire Record of the N. F. P. A. Executive Office decided to make an investigation of all the reports of sprinklered fires in its files.

The following data shows, in brief, the results of this investigation.

Number of sprinklered fires reported	35,000
Fires in which loss of life occurred	45
Number of lives lost in these fires	202

The forty-five fires in which lives were lost divide as follows:

	No. of Fires	No. of Lives Lost
Explosions	20	124
Flash Fires	17	34
Sprinklers shut off	2	4
Firemen killed in performance of their duties	2	3
Rapid spread of fire	2	2
Suffocation by fumes	1	3
Building collapse	1	32
Total	45	202

As these forty-five fires are of interest in showing the conditions under which automatic sprinklers failed to protect life, a brief summary of the important data in each fire is given as follows:

Explosions.

S-3556. MARCH 20, 1905. SHOE FACTORY. At about 8 A. M. a boiler located in a brick addition to the main factory exploded. The boiler was blown a distance of 200 feet and the factory was practically demolished by the explosion. The sprinkler pipes were broken by the explosion and fire, which ensued almost immediately, spread rapidly. Fifty persons lost their lives. There were about two hundred in the factory at the time of the explosion. The property loss was over $250,000.

S-6235. OCT. 7, 1907. FOUNDRY. An explosion was caused when a ladle containing several tons of molten iron was overturned into a pool of water. A hot blast from the explosion opened 325 sprinklers. The sprinklers held the resulting fire in check and the fire department readily extinguished it with a few hose streams. Forty-two men were severely injured by the explosion; four of these died soon after.

S-6365. JULY 10, 1907. PYROXYLIN PLASTIC FACTORY. An employee was feeding sheets of pyroxylin plastic into a "cracking" machine. Two others were emptying a barrel of alcohol into an adjacent tank. Fire burst out at the machine from unknown cause. The vapors in the nearly empty alcohol barrel exploded, fatally injuring one and seriously injuring the other two. Four sprinklers opened and held the fire in check with small damage.

S-7783. JULY 16, 1908. PIER WAREHOUSE. Two boxes of "detonating corks" were being examined by customs officials. An explosion, probably caused by renailing one of the cases, instantly killed three men. The explosion broke the sprinkler pipes. The small fire which ensued was readily extinguished by employees.

S-17329. SEPT. 21, 1914. PULP BOARD MILL. The explosion and fire occurred in a small building used for mixing a waterproofing compound consisting of rosin, benzol and alcohol. A boy had been sent to lock up the building for the night. The explosion, of unknown origin, practically demolished the building and the sprinkler system. The boy was burned to death. Employees extinguished the fire with small property loss.

S-17907. MAY 12, 1915. CHEMICAL PLANT. An explosion of unknown cause occurred in a one-story frame building used for dehydrating nitrated cotton. Three men were burned to death. The building and the sprinkler system were wrecked by the explosion. Employees extinguished the fire with small property loss.

S-18807. DEC. 21, 1915. CORN OIL PRODUCTS FACTORY. A terrific explosion of unknown cause occurred in the dextrine dust house. One man was killed and several others were badly injured. The sprinkler system was wrecked by the explosion. The fire was extinguished with hose streams.

S-18808. DEC. 23, 1915. MUNITIONS FACTORY. An explosion occurred at an oven when the gas was turned on and not lighted. The gas ignited from flames of other ovens. One man was instantly killed. No fire followed the explosion.

S-18545. DEC. 31, 1915. LINSEED OIL MILL. An explosion of unknown cause occurred in a building containing considerable naphtha and other volatiles. Two men were killed and several injured. The sprinkler system was wrecked and the fire was extinguished with hose streams.

S-22161. DEC. 11, 1916. CEREAL MILL. A serious explosion of grain dust followed by a severe fire caused the death of twenty-two persons. The explosion broke all steam connections from the boilers and a six-inch sprinkler riser. Practically all the sprinklers were fused by the first blast of flame and the street mains were utterly inadequate to maintain sufficient pressure. The entire group of buildings in the plant was destroyed.

S-21361. MARCH 6, 1917. AUTOMOBILE FACTORY. A foreman, who was behind in his schedule, ran some freshly dipped parts into a bake oven, without allowing the oven to cool or the parts to drip properly. Within a few minutes a terrific explosion occurred, demolishing the oven and killing five men. Sixty-eight sprinklers opened and extinguished the fire which followed.

S-23713. JULY 3, 1917. POWDER PLANT. A serious explosion was caused when a spark, probably from a match, was struck by an employee dragging a box over the floor. The explosion blew the roof off the building, breaking the sprinkler pipes at the same time. Four men in the building were burned to death. The building was totally destroyed.

S-22211. SEPT. 17, 1917. ELECTRIC LAMP WORKS. A gas explosion, which occurred in the gas meter room of the plant, instantly killed the master mechanic, who had entered to investigate a leak. The roof was lifted by the explosion and the sprinkler pipes were broken. No fire followed the explosion.

S-22132. NOV. 26, 1917. DEPARTMENT STORE. In the basement of the store there were two power and heating boilers using crude petroleum

oil for fuel. It was customary to alternate the boilers from day to day except in very cold weather, when both were used. Repairs were made on one boiler and the oil burner was then started and pressure raised to 125 pounds. As the pressure of the other boiler was 100 pounds the first boiler was shut off to allow the pressure to drop to 100 pounds. The fireman then opened the valve in the oil supply without lighting the oil, apparently expecting that the heat from the brick in the fire box would be enough to ignite the oil as it had in times past. The brick-work was not hot enough to ignite the oil but yet was hot enough to allow an oil gas to be generated. This gas collected in the fire box as the damper was closed. After a time the fireman applied a light of some kind and immediately the gas ignited and an explosion occurred which blew open the fire box doors and let a blast of flame into the room. Two men were burned to death. Two sprinklers opened and held the fire in check. The fire was extinguished with hose streams.

S-22642. Nov. 5, 1917. Aluminum Plant. A spark struck from a sledge hammer ignited some fine aluminum dust. Employees tried to extinguish it with sand but were unsuccessful. This room was unsprinklered and the fire spread very rapidly. Firemen played a hose stream into the adjoining sprinklered building which had caught on fire and caused a dust explosion which lifted the roof of the building and broke off the sprinkler system. Seven men were burned to death and fifteen seriously injured. The fire was then allowed to burn itself out.

S-22523. Jan. 24, 1918. Garage. The operator of a motor truck was filling the gasoline tank from a can. The can hit a metallic portion of the truck and struck a spark which ignited the gasoline vapors. An explosion occurred fatally burning the operator. Four sprinklers opened and extinguished the fire with small property loss.

S-23248. April 6, 1918. Bolt and Nut Works. A specially designed device for lubricating a drill contained lard oil and air compressed to about 300 pounds. The bottom flange of the device blew out without warning, throwing oil on surrounding machinery and over the clothing of workers nearby. This oil ignited from a broken electric light bulb and seven employees were burned to death and five seriously injured. One hundred and eight sprinklers opened and promptly extinguished the fire, probably saving other lives.

S-27465. Feb. 26, 1920. Aluminum Plant. An explosion of aluminum dust in the blower system, caused by a piece of wire striking the blower fan, resulted in the death of six employees. Three sprinklers opened and quickly extinguished the resulting fire.

S-34691. April 5, 1923. Dye Works. An explosion, probably due to some foreign substance in the batch, burst a spherical ball mill used in grinding a dye. Two men were burned to death and four others seriously burned. Sixty-two sprinklers on the first floor and twenty-four on the second floor were opened by the flash of flame from the explosion. They operated for a few minutes and entirely extinguished the fire.

S-34685. May 8, 1923. Cereal Mill. An explosion of unknown origin wrecked the two top stories of a grain elevator and the ensuing fire entirely destroyed these two floors. An employee in the section at the

time was burned to death. Many of the sprinkler pipes were broken by the explosion. About 175 heads opened but there were so many broken sprinkler lines that the static pressure was just enough to let water dribble out of the sprinklers. The fire was controlled by hose lines.

Flash Fires.

S-6879. SEPT. 30, 1908. PRINT WORKS. An employee was opening a keg of sodium chlorate when it suddenly burst into flame and he was fatally burned. Nine sprinklers opened and promptly extinguished the fire.

S-7975. OCT. 19, 1908. PYROXYLIN PLASTIC FACTORY. Two employees were passing sheets of pyroxylin fresh from the dryers through a breaker to turn the sheets into a flakey pulp. There was about 350 pounds of the material in the room. A spark from the breaker ignited this stock and a blast of flame filled the room. The two employees were burned to death. Ten sprinklers opened and promptly extinguished the fire with small property loss.

S-14638. MAY 29, 1913. TENANT MANUFACTURING. Fire occurred on the twelfth floor in a shop where a mechanic was working on an automobile. The mechanic broke an electric light bulb and set fire to a tank of gasoline. The flash fire fatally burned him. Twenty-eight sprinklers opened and controlled the fire with small loss.

S-15161. SEPT. 1, 1913. TENANT MANUFACTURING. The fire occurred in a shoe shop on the fifth floor. A gust of air blew a piece of tissue paper into the flame of an alcohol lamp and then into a dish of gasoline used in cleaning shoes. The dish was upset on to the floor and a girl employee tried to stamp out the flames. Her dress caught fire and she was fatally injured. The fire was put out by chemical extinguishers before sprinklers operated.

S-15362. OCT. 24, 1913. WORSTED MILL. A slight explosion or puff in the gauze room sent a blast of flame out on two men who had been feeding a picker in the adjoining room. Both men were fatally burned. Eight sprinklers opened and controlled the fire with small property loss.

S-16198. MAY 27, 1914. DEPARTMENT STORE. The building was in process of construction. A painter who was doing some work on a switchboard set a pail of japan paint across two bus-bars. The "short" burnt the bottom off the pail and ignited the paint which flashed up over the man. He was badly burned and died soon afterwards. One sprinkler head opened and extinguished the fire without property loss.

S-16846. OCT. 8, 1914. PYROXYLIN PLASTIC FACTORY. The fire occurred in the mixing machine room where pyroxylin is mixed with wood alcohol. There were about 375 pounds of dry pyroxylin in the room. This ignited from some unknown cause, probably a spark caused by friction. The blast of flame burned five employees so badly that they all died. Thirty-eight sprinklers opened and extinguished the fire with small property loss.

S-18663. MARCH 30, 1916. MUNITIONS WORKS. The fire occurred in the final mixing building for a powder consisting of gun cotton and nitro-glycerine. The building contained sixteen separate rooms. Each

room had a large bread mixer. The mixer in one room was charged with 400 pounds of scrap powder which ignited. Flames shot fifty feet into the air. The two men in the room were burned to death. The flames ignited charges in six other rooms and opened forty sprinklers. The water pressure was low at first but when the fire pump was started the fire was readily extinguished by the sprinklers.

S-19180. MARCH 4, 1916. RAINCOAT FACTORY. The fire was caused by an employee using a heavy metal can containing naphtha. He struck the can on the rim of a metal rubber cement churn, causing a spark which ignited the naphtha fumes. Two men were fatally burned. Twenty sprinklers opened and practically extinguished the fire.

S-20886. MARCH 14, 1917. MUNITIONS FACTORY. A flash fire of unknown cause occurred in the ether recovery building. Six employees were burned to death. The sprinkler equipment was of no value as the fire spread practically instantaneously and consumed the entire building and its contents. About 55,500 pounds of powder were consumed.

S-21679. JUNE 30, 1917. CHEMICAL WORKS. An employee was tending a nitrating kettle when a violent chemical reaction occurred and the gaskets at the top of the kettle blew out. The material inside was discharged into the room and ignited. The employee was fatally burned. Thirty-five sprinklers opened and extinguished the fire.

S-21484. OCT. 8, 1917. PYROXYLIN PLASTIC FACTORY. The fire occurred in a mixer from unknown cause. There had been some trouble in starting the machine and the foreman was trying to find the trouble when the flash occurred. Five men were burned to death. Eighteen sprinklers opened and practically extinguished the fire after a few minutes. The loss was small.

S-23705. JULY 2, 1918. POWDER PLANT. A flash fire occurred when some powder in a solvent recovery room dropped down between baffle plates on to steam coils. An employee in the room was burned to death. Twenty sprinklers opened and held the fire in check with small loss.

S-26719. NOV. 5, 1919. FURNITURE FACTORY. A negro, having a grudge against a white boy, walked into the supply room and deliberately threw a lighted match into a pail of volatile "wax" which the white boy was drawing from a barrel. The clothes of the latter ignited and he ran out of the room into the main varnish room, igniting a drip tank and causing 120 sprinkler heads to open. The boy was burned to death. The sprinklers controlled the fire.

S-27768. APRIL 20, 1920. CHEMICAL PLANT. A spark from a cigarette ignited a drum of toluol causing a flash fire which burned one man to death and seriously injured another. Thirty-one sprinklers opened but could not extinguish the fire as water had no effect on the burning toluol. The building was of reinforced concrete and was not badly damaged.

S-31092. JUNE 22, 1921. SHOE FACTORY. A watchman was burned to death when his kerosene lantern ignited fumes from the storage room for benzine and rubber cement. Six sprinklers opened and extinguished the fire with small property loss.

S-31532. Nov. 14, 1921. Machine Shop. An employee was using gasoline for cleaning when it became ignited. The man started to run about the room and two sprinklers opened but did not extinguish the fire as the man was moving about. The man was fatally burned. The fire was extinguished by hose streams with small property loss.

Sprinklers Shut Off.

S-10253. Feb. 17, 1910. Metal Worker. The fire occurred in the lacquer room, probably due to defective electric wiring. The contents of a dip tank ignited and the fire spread very rapidly. Intense heat and smoke were generated and two employees were suffocated. The sprinkler system had been shut off on account of a leak in an underground supply pipe. About five minutes after the start of the fire the sprinkler system was turned on and 324 heads opened. The water supply was good and the sprinklers checked the fire.

S-34400. Jan. 7, 1923. Pulp Mill. Fire started in the bottom of a large chip bin due to steam pipes coming in contact with chips. To prevent danger of freezing a dry pipe valve had been purchased but had not been installed and the supply lines had been disconnected. A man with a hose was unable to extinguish the fire and the fumes suffocated two men before the seriousness of the situation was realized. The chip bin burned itself out but sprinklers in the digester building opened and prevented further spread of the fire.

Firemen Killed in Performance of Their Duties.

S-18042. June 22, 1915. Oil Cloth Factory. Fire started near the coating room which contained quantities of inflammable materials. The sprinkler system was poorly arranged, all heads were 286 degree, and oilcloth hung in festoons seriously obstructed distribution. The sprinklers did not check the fire, which spread rapidly. Two firemen were killed when a wall fell in.

S-20726. Jan. 20, 1917. Theatre. The fire occurred in a blind space between the ceiling and the roof and spread to the rear and sides of the theatre. This portion of the building was unsprinklered, sprinklers being confined to stage and dressing rooms. A wooden roof truss collapsed during the fire, resulting in the death of one fireman and the injury of nine others. When the fire reached the sprinklered portion two heads opened and checked further spread.

Building Collapse.

S-10028. July 13, 1910. Newspaper Plant. The collapse of part of the building and a sprinkler tank on it caused a fire by scattering coals from stereotype furnaces on the fourth floor. The sprinkler system on the fourth and fifth floors was destroyed by the building collapse. Thirty-two persons lost their lives either from the collapse or the ensuing fire. (For detailed report see Quarterly, Vol. 4, No. 1, p. 110.)

Rapid Spread of Fire.

S-16713. April 21, 1914. Bleachery. A singeing machine was located in the second story of a mercerizing building two stories high. A gas flame ignited the cloth which was running through the machine. The fire travelled rapidly through a wooden chute connecting the singeing machine with the mercerizing machine on the floor below. It flashed back

up the chute with great force, mushroomed across the second floor and the heat opened 318 sprinklers. A check valve closed between the fire pump and the sprinkler system resulted in poor water supply to the sprinkler system. The fire was finally extinguished by hose streams. Of two men working at the singeing machine at the top of the fire, one was overcome by smoke and suffocated. The sprinkler head above the top of the chute was prevented almost entirely from distributing water, because of a timber which had been used for shafting.

S-21882. Oct. 29, 1917. Mattress Factory. The fire occurred in storage bins containing silk floss. The fire spread so rapidly that three employees were burned in escaping; one fatally. Twenty sprinklers opened and extinguished the fire.

Smothered in Tank.

S-31651. Dec. 30, 1921. Locomotive House. The thirty-five gallon feed tank of an oil burning locomotive was being filled from a 300 gallon gravity tank. The burner under the locomotive was in full operation with the fire box door open. A flash occurred in the cab which set the clothing of the engineer on fire and a second flash followed which filled the building with flames. Three men working inside the tender of a locomotive nearby were suffocated. The engineer and three other men escaped. Twelve sprinklers opened and extinguished the fire with small damage.

Conclusions.

An analysis of these forty-five fires shows the following data on the performance of the sprinklers:

Action of Sprinklers	No. of Fires
Extinguished fire	19
Held fire in check	5
Unsatisfactory	4
Crippled by explosion	13
Shut off	2
None opened	2
	45

It is interesting to note that in only four cases was the operation of the sprinklers unsatisfactory and in no one of these four fires can the loss of life be attributed to failure of the sprinklers.

As can be seen from the reports these fires occurred from many different causes and in many occupancies. The handling of such substances as gun powder pyroxylin plastic and gasoline necessarily creates a life hazard which sprinklers could not be expected to provide against and it is surprising how few of such casualties are reported.

Loss of life is not always considered important by the inspector as is evidenced by the following, extracted from one of the reports:

Relative Loss: Slight, except seven people killed and five others badly burned.

When it is considered that in 35,000 fires in sprinklered buildings there is a loss of life of only two hundred and two persons and that all of these persons lost their lives in serious explosions or fires which the sprinklers could not be expected to control, the value of the automatic sprinkler as a life saver is demonstrated beyond question.

Two Tenement Holocausts.

Inferior construction and sub-standard stairway enclosures were responsible for the death of twenty-two people, in two recent tenement fires in New York and Chicago. The lesson taught by these two fires is not new, but the fact that these losses of life occurred in buildings which were not of sufficiently defective construction to appear to the layman as obvious firetraps, makes them of especial interest. The New York fire was in a brick building with a brick enclosed stair shaft. The Chicago fire was in a brick building only three stories high, within two blocks of a fire department station. The layman would have regarded both these buildings as comparatively safe, as most of the obviously dangerous conditions characteristic of the firetrap were absent. In fact, his opinion would probably have been correct as to the comparative hazard of these and thousands of other existing buildings obviously more dangerous. But in each of these buildings there were fatal defects, as is shown in the following reports.

The New York Tenement Fire.*

The tenement at 69 East 109th Street, involved in the fire of April 27, 1923, was an old type brick structure with a bakery, tailor shop and shoe repair shop on the first floor and apartments on the upper four floors, four families to a floor.

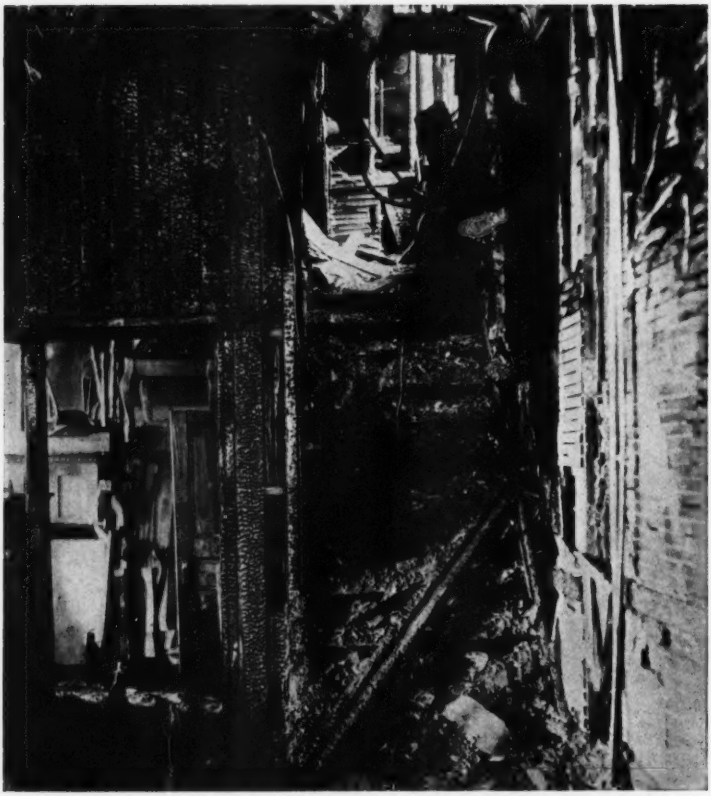
The type of the building is clearly illustrated in the accompanying photograph. The stairs were located in the center of the building and enclosed in a 16 in. brick shaft, but with only wooden, plain glass paneled, doors to the floors. There was also a wooden lath and plaster air shaft in this stair shaft.

The building had two outside vertical ladder type fire escapes, one at the front and one at the rear. As the fire started at the rear end of the hallway at the foot of the stairs, it cut off the front from the rear portion of the building. The fire was first noticed by a person across the street at 3:17 A. M. The fire had evidently been burning for some time. The loss of life was undoubtedly caused by suffocation before the people had any opportunity to escape. Although, as shown by the illustration, the fire escapes were of decidedly sub-standard type, many people were able to escape by this means. Many others were rescued by the firemen. Twenty persons were injured, largely from burns and not from falling or jumping. The twelve bodies were removed from the upper floor.

The importance of having stairs of fire-resistive construction, and the exclusion of all other shafts from the stair shaft is apparent. The

*Data furnished by C. T. Vilade (Member N. F. P. A.), New York Board of Fire Underwriters.

The tenement on 109th Street, New York, where twelve people were burned to death. Improper stairway construction was responsible for the rapid spread of the fire.



This was the only exit from the tenement on Federal Street, Chicago, where ten persons lost their lives. All of the occupants of the upper floors had to jump from the windows.

installation of fire doors at all openings from the stair shaft to the interior of a building is also an obvious necessity. The lessons of this fire have long since been learned. The defects which contributed to loss of life in this case have for a long time been prohibited by law in the erection of new buildings.

The Chicago Tenement Fire.*

The tenement at 2138 Federal Street was a three-story and basement ordinary joisted building, built about 1897. The walls were of brick and the partitions were of wood lath and plaster. There was one central stairway in a wood lath and plaster shaft with ordinary wood paneled doors to the floors. The first floor was occupied by a second-hand fur-

*Data furnished by The Chicago Board of Underwriters (Member N. F. P. A.)

niture company and the two upper floors were used as small flats occupied by approximately sixty negroes.

On June 21, 1923, at about 3 A. M. the fire originated at the ceiling of the basement from a gas flame. A gas bracket was installed between two joists and within four inches of the combustible flooring above. The flame burned through this floor igniting the wood lath and plaster partition enclosing the only stairway. The fire was not discovered until one of the firemen on duty at an engine house two blocks away saw the flames shooting across the street from the store on the first floor. This was at 3:54 A. M., and when the fire department arrived the fire was burning all through the center of the building and several of the people on the upper floors had jumped to the cement pavement below. It was impossible for those on the upper floors to get out except through the windows. Ten persons lost their lives, some by jumping to the pavement, and nineteen persons suffered injuries.

The hazards of unsafe gas brackets is clearly emphasized by this fire. The lack of intelligence of the person who installed this bracket is inexcusable. The construction of the building was such, however, that the result might have been the same had the fire started from any other cause.

The Essex Castle Apartment Fire.

Lynn, Mass., April 19, 1923.

By H. S. Walker

Five persons were burned to death and two later died in hospitals as a result of a fire which gutted the Essex Castle Apartments at 4 Ellis Street, Lynn, Mass., early in the morning of April 19, 1923.

The building was a four-story structure of wooden, brick veneered, construction approximately 150 ft. by 100 ft. It contained 48 apartments housing about 100 people.

The building had a main entrance on a front hall and open stairways running to both the left and the right and leading to the centre of each side of the structure on each floor. The only other entrance to the building was a small basement door at the rear but this entrance did not connect with a stairway to the upper floors. Thus the main entrance was the only available escape for the whole building. There were no fire escapes, sprinkers or other means of fire protection.

The fire probably started in a waste chute running from the top floor to the boiler room. The fire spread up the chute and mushroomed out on the third and fourth floors. There was considerable delay in notifying the fire department. As the fire occurred about two o'clock in the morning, all the tenants were asleep. A passing policeman first noticed the smoke and turned in the alarm. The nearest alarm box was approximately a thousand feet from the building and this defect also caused delay. A few of the tenants on the lower floors were able to reach safety through the main entrance but the flimsy construction of the building and the open stairways made the spread of fire extremely rapid and this method of escape was soon cut off. When the fire department arrived, the upper

Seven persons were burned to death in this wooden, brick veneered, apartment house in Lynn, Mass.

floors were a mass of flames and attention was devoted entirely to rescue work. Twenty-one persons were taken down ladders and seventeen were caught in life nets. The firemen found it impossible to go above the second floor. The fire department did effective work in confining the fire to the one building. The building was in a shingle roof district and was surrounded by three-story frame tenements. Hose streams kept these buildings wet down and as there was no wind at the time the fire did not spread. The property loss was approximately $75,000.

Conclusions.

It is hardly necessary to point out the criminal carelessness in allowing a structure of this sort to be erected and maintained. The inferior type of construction, lack of fire protection, and inadequate exit facilities of this building should have condemned it long before the fire.

Three Notable Fires in Pyroxylin Plastic Manufacturing Plants.

By W. D. Milne.
(Member N. F. P. A.)

Three serious fires which have occurred recently in plants manufacturing pyroxylin plastic well illustrate a number of points to be considered in the provision of proper equipments of automatic sprinklers, and other measures of protection necessary where pyroxylin plastic is present in quantity.

The first of these fires occurred in the nitrating and washing building of a large plant. For a proper understanding of this case the essential features of the arrangement, occupancy and protection of the building should be known.

The building was one and two stories and basement, of brick mill type, about 194x122 feet over all, but divided by brick walls into six approximately equal sections. The upper floors were occupied for the cutting and drying of the paper stock and the charging of the nitrators. The first floor was occupied in four of the sections for washing the nitrated stock (pyroxylin). The equipment for washing the stock consisted of large oval tubs equipped with paddle wheels, the whole being quite similar to the washers in a paper mill. The object of the process was to free the nitrated stock from the acids of the nitration process, and this was accomplished by means of washings in two separate sets of tubs, the operations being known as "acid wash" and "finishing wash." The whole occupancy of these rooms with their steamy atmosphere and wet processes, did not suggest a severe fire hazard, but there were certain features that made severe fire possible. The wooden tubs were lined with sheets of pyroxylin plastic, and the large hoods over the paddle wheels, and troughs used for conveying the pyroxylin, with water, from one tub to another, were built of the same inflammable material. The troughs extended through unprotected openings in the division walls in such a manner as to impair the fire cut-off between four sections of the building. Although the building was equipped with sprinklers, there were no sprinklers beneath numerous wooden hoods over the wash tanks, placed there to prevent drip and foreign matter falling into the stock. This condition had been noted upon inspection reports, and proved to be a serious defect, since the hoods prevented water from sprinklers reaching the troughs and paddle wheel covers referred to above.

Although the processes in the wash room keep the pyroxylin stock wet with such an excess of moisture that it is not combustible, small quantities of freshly nitrated stock may inadvertently escape from the tubs and dry out. Raw pyroxylin in such a condition is unstable and liable to spontaneous decomposition or combustion. It is supposed that in this case

a small quantity of stock on the edge of a tub in the first story thus took fire, and ignited the sheet pyroxylin of the conveyor trough above it.

The fire started at about 7.50 A. M., and while the plant was in operation. According to the stories of the men present the fire spread with great rapidity, and while none stayed to closely observe its first spread, it is quite evident that once the fire engaged the considerable quantity of pyroxylin plastic present in the linings, covers, and troughs, it would spread rapidly, igniting by its heat similar material on all the equipment in the room, and extend through openings in the division walls. This quite evidently occurred and the sprinklers had little or no effect in preventing or slowing down this spread of fire, since they were to a large extent obstructed by the wooden hoods. The fire soon involved four sections of the first floor, and extended by means of a ventilating duct into the second floor, and became general in the building. While the quantity of pyroxylin plastic was considerable, it was not sufficient to long sustain in any one area the violent combustion characteristic of this material. The really serious factor was in the wide initial spread of the fire, and the dissipation of the value of the sprinkler system through the opening of many sprinklers. The heat generated from the combustion of the pyroxylin plastic, as frequently happens, opened sprinklers far from any fire, while the fire at first was largely under the hoods where the water from sprinklers could not reach it.

Hose streams were promptly used by employees and the public department was called. With fire in progress in four sections and two stories of the building, even the most efficient fire department would find it difficult to quickly control it, while the sprinkler system, discharging from some 335 sprinklers, could not be expected to deliver water from each sprinkler under conditions which would be effective.

The fighting of the fire merits praise in that the destruction of the entire plant, to say nothing of the building itself, was prevented, and a considerable part of the contents of the building saved. This could not have been accomplished, however, if the water supply had not been unusually powerful. It is estimated that the twelve hose streams and the 335 sprinklers discharged about 2,800,000 gallons of water during the fire. The water was supplied by a public gravity supply under 90-100 lbs. pressure through a 30-inch main. This supply was augmented by a 1,000 gallon fire pump drafting from a cistern, and later by letting in another public water supply through the same 30-inch main at 80 lbs. pressure, after the pressure on the initial supply had fallen to about 72 lbs. The water supply at the plant had, not long previous to the fire, been augmented upon the suggestion of an inspector, and it is quite apparent that all the resources at hand were called into use.

In a general way, the fire simply illustrates the importance of the fundamental principles of fire protection, namely, that sprinkler protection should be 100% complete, and that vertical and horizontal cut-offs should be positive in effect. It emphasizes again the speed and violence of combustion of pyroxylin plastic, and shows the need for an abundance of water at high pressure, and the close limitation of the fire area where this material is present.

In particular, this fire illustrates the extreme danger incident to the use of pyroxylin plastic in tank linings, covers and troughs, this inflam-

mable material forming in effect a fuse train for rapidly spreading fire. It also shows the need for unpierced fire division walls and for release devices more sensitive than the ordinary fuse links, on such fire doors as are necessary.

The Second Fire.

The second fire, though of less extent, gives no less striking evidence of the violence of fires involving pyroxylin plastic in quantity.

The plant involved in this fire was one manufacturing sheet and rod stock, using some nitro-cotton, but mostly scrap celluloid as raw material. The plant was of fairly recent construction and the layout was good in that the various processes were well separated, there being twelve buildings with open spaces of 75 to 80 feet between them. Further isolation of several of the buildings was effected by the use of blank exterior walls and fire doors. An equipment of automatic sprinklers had been installed more or less in accordance with the rules which are followed in providing such equipments in factories of ordinary hazards, though the water supply provided was admittedly weak. As had been predicted and as the event proved, this sprinkler system was entirely inadequate to furnish protection.

The fire occurred in the stuffing building, a 43 feet by 43 feet one-story and basement joisted structure occupied in the basement for rack storage of rod and tube stock and in the first floor for the process of "stuffing" or extruding these rods and tubes from a mass of soft pyroxylin plastic in a steam-heated cylinder. Sprinklers were provided in the basement and first floor, spaced 8 feet by 8 feet under open joists. They were supplied by a 3-inch pipe from a 6-inch yard pipe connected in turn through about 2,200 feet of 6-inch street main to a gridiron system. The water pressure was 110 lbs., but under the draft of a 1¼-inch pipe this fell off to 70 lbs., indicating a scanty volume of water available.

The fire started while the plant was in operation but neither the cause nor the exact point of its origin has been ascertained. Smoke was noted coming from the basement, where a large amount of stock was present. Alarm among the mill employees was promptly given, but little water was available from the two lines of hydrant hose which were promptly laid by the mill force. Very shortly after the start of the fire an explosion more or less demolished the building. The public fire department apparently did not receive a prompt alarm, but upon their arrival about ten minutes after the start of the fire, they extinguished, with engine streams, the blaze in the remnants of the structure.

Although about 65 sprinklers operated, they apparently had little effect on the fire. The flow from these sprinklers so reduced the pressure on the water main that effective hose streams were not available.

The evidence in regard to the explosion is not satisfactory, but it would appear that this explosion was not due to the building up of pressure in confined gas of decomposition. It seems more likely that it was similar in its nature to the commonly noted "hot-air explosions," and occurred in a cloud of gas produced by the decomposing material.

The fire was confined to the building of its origin, but according to the accounts, neighboring buildings were subjected to considerable exposure, showing that the spacing between the buildings was none too liberal.

The fire emphasizes the danger of storing pyroxylin plastic stock in proximity to manufacturing processes. In this case the operation of the plant was seriously interrupted. It shows the futility of providing sprinkler equipments proportioned for ordinary hazards, to cover pyroxylin plastic hazards.

The Third Fire.

The third fire, on account of the simplicity of the circumstances, presents a rather striking example of the results that may be expected from the combustion of pyroxylin, and particularly, of the danger from scrap material.

The scene of the fire was in a group of three wood, metal-clad, storage buildings, located at a little distance from a large pyroxylin plastic manufacturing plant. Each building was 40 feet by 60 feet one high story, not equipped with sprinklers and occupied for the storage of pyroxylin plastic scrap in wooden cases deeply piled. The buildings were 40 feet apart, in a triangle.

The weather for several days before this fire had been exceedingly hot. The buildings had been opened at various times during this period. At about 8.30 o'clock in the evening, a watchman at the main plant observed an explosion in one of the buildings. This explosion partially wrecked the building and was accompanied or immediately followed by a burst of flame. Explosions in the other two buildings followed almost at once and the material in all three burned with extreme violence. Public alarm was promptly given, but by the time hose streams were available, it was useless to attempt to do anything but save surrounding property. A wooden dwelling 87 feet away was seriously burned on one end and another dwelling about 140 feet distant was slightly damaged. Gardens, chicken coops, fences, etc., in a considerable radius were damaged. The fire in the storage buildings practically burned itself out.

Presumably the fire started from the slow decomposition of scrap stock. The hot weather, encouraging the action of unstable elements in this stock, may be given as the immediate cause. The decomposition once started, would cause at once a building up of the temperature in the tightly packed material and the generation of a cloud of inflammable vapor in the building. When the temperature mounted sufficiently, flame appeared and the gas cloud was ignited, causing the initial explosion.

Pyroxylin plastic scrap is at best very dangerous stock, and as it is collected from various sources, inferior material, dirt, oily material, charred scrap and other dangerous material may be included with it. As in this particular case, the scrap may lie for two or three years, giving ample opportunity for the development of unfavorable reactions.

The money value of the scrap lost in this case was considerable. An ordinary sprinkler system, if it had been present, would have been utterly powerless to prevent this loss. Probably the most satisfactory provision for scrap storage in most cases is to erect isolated storage buildings of not over ten tons capacity each, and so arrange and separate them that fire cannot extend from one to another, but even among manufacturers there is a failure to realize the necessity for stringent measures to secure adequate isolation.

Hot Springs Fire and Flood.

By T. F. Baker,

Arkansas Fire Prevention Bureau.
(Member N. F. P. A.)

The old saying that troubles never come singly was verified in the City of Hot Springs, Arkansas, on the evening of May 14th, when that world famous resort was visited by both flood and fire. While many of the newspaper accounts, particularly those appearing in eastern papers, were grossly exaggerated, yet there was considerable damage done to store fronts and stocks of merchandise by the flood, and almost one city block was totally destroyed by fire.

Hot Springs was originally laid out on either side of Hot Springs Creek which wound its way along a narrow valley lying between mountains which form a part of the most southern range of the Ozarks. In the early days business houses on either side of this creek were connected by wooden bridges, but in the early eighties the creek was arched over with stone and concrete and a permanent street built thereon, so that a stranger would not suspect that a constantly flowing stream fed by mountain springs was under the center of the street. This same creek also forms the only drainage outlet for a considerable water shed. The water that fell on the evening of May 14th was entirely too much to be carried away by the hedged-in creek; therefore it followed the course of the stream on top of the street and continued to rise until it was more than four feet deep on the level. Some idea of its terrific driving and pulling force may be had from the effect produced upon the asphalt pavement, which was literally torn from its concrete base and piled up along the curb.

While the water was at its height in the street, fire was discovered in a furniture store in one corner of a block about the center of the flood area. The cause of the fire has been ascribed to lightning; however, there is no positive evidence that this theory is correct although a severe electrical storm was raging at the time. The fire department was powerless to fight the fire for the reason that the hydrants were all submerged, and furthermore it was a physical impossibility for apparatus even to move in the torrent, to say nothing of the ability of man to stand and direct a hose stream. The fire department and the citizens were helpless in the situation and could only stand on the mountain sides and watch the flood recede and the fire burn itself out.

The last building to burn was a five-story hotel consisting of two types of construction, the side next to the origin of the fire being ordinary wood-joisted type, followed by a section having reinforced concrete columns and girders with brick panel walls, communicating halls protected with standard automatic fire doors. Fire entered this fire-resistive section, however, on account of failure of two of the panel walls, and destroyed all of the contents of the fire-resistive section, burning itself out therein without further spread. There was a failure of four of the outside wired

An unusual photograph showing fire, lightning, and flood at Hot Springs.

glass windows, these being opposite the brick panel walls that failed.

There are no special lessons to be learned from this fire that have not been previously demonstrated. The city of Hot Springs is wholly back to normalcy and the only visible evidences of the catastrophe at this time are the remains of the fire where the loss was approximately $400,000, and the busy workmen replacing the asphalt pavement.

The Hughes-McKie Oil Well Fire.

Twelve lives were lost as a result of an explosion and fire at the J. K. Hughes Development Company's McKie No. 1 well in the East Navarro County field, eleven miles southwest of Corsicana, Texas, at 2:45 o'clock on the afternoon of May 9, 1923.

The well came in late the night before and was flowing 5,000 barrels of pipe line oil a day. At ten o'clock on the morning of Wednesday, May 9th, the control head burst and a gang of men were at work putting in a new head. The fire was probably caused by a spark made by pebbles thrown from the well coming in contact with the new steel control head. The clothing of the men at the well was saturated with oil and they were almost instantly burned to death at the first flash from the well. The flames from the well shot 100 feet high and about 1,000 barrels of oil

A close-up of the Hughes McKie oil well fire. The photographer was within 30 feet of the well. His clothes were ruined and his camera was burned.

which had accumulated about the well forming two large pools, each covering more than an acre, also ignited.

Great difficulty was experienced in recovering the bodies and in extinguishing the fire. All of the men familiar with the well perished in the flames. For three days no progress was made. Twelve steam boilers

were assembled and the steam was turned on Tuesday, May 15th, but without effect on the fire. On Sunday and Monday, May 13th and 14th, a rescuer, clad in an asbestos suit, succeeded in gathering the remains of the twelve bodies.

Steam, foam, water and dynamite were all tried on the fire but without avail. The fire was finally extinguished on Sunday, May 20th. A T-shaped pipe with two gate valves was used. The diameter of this pipe was about one inch larger than that of the pipe out of the ground. This T-shaped pipe was suspended in the air and pulled over the well with wire cables. At the same time four hose streams were directed at the well so as to drive the blaze higher up. The pipe was pulled over the fire with the top gate valve open and the gate valve in the side pipe closed. After the pipe was in place sacks of dirt were piled around it to weight it down and then the side pipe gate valve was opened. The oil was in this manner separated from the flame. The pipe from this valve led into tanks at some distance away. The top gate valve was then closed slowly by means of a long key and the fire went out as simply as a gas jet being turned off.

Three Interesting Bridge Fires.

Bridge fires, like forest fires, are most prevalent in the dry summer season, and if the fires already reported this season are taken as an indication of the extent of bridge fires this summer, 1923 will not see any reduction in the bridge burnings of previous years. The destruction of a bridge usually involves an indirect loss and inconvenience out of proportion to the direct fire loss, and the importance of continuing uninterrupted traffic more than justifies strict fire prevention precautions. QUARTERLY readers will remember the report of the Co-operative Committee on Highway Bridge Fire Protection, published in the January issue (p. 246). Three important bridge fires within the period May 24 to June 6, 1923, furnish an interesting supplement to this report. The circumstances of one of these fires were very unusual; a derailment of a railroad train containing tank cars resulted in a fire of oil and gasoline floating on the surface of the water. Not only was the steel work of this bridge a total loss but the limestone piers were so badly damaged as to require rebuilding. The following data on these three fires is furnished by the *Engineering News Record* (Member N. F. P. A.):

The Fort Madison Railway Bridge Fire.

The bridge of the Atchison, Topeka & Santa Fe Railway over the Mississippi River at Fort Madison, Iowa, is 2,960 ft. long and has about 1,000 ft. of pile structure with creosoted ballast deck, at the east end. On either side of the railway deck is a wagon driveway, which in the trestle portion descends on a 4 per cent grade to the east until low enough to pass under the railway trestle, at which point the north joins the south roadway. On May 24 fire was discovered in the sag of the roadway where it crosses under the railway deck, according to the report of A. F. Robinson, bridge

engineer of the railroad. A strong wind prevailed, and when the fire was put out some 400 ft. had been burned and both wagon driveways destroyed from the middle of the east steel span to the east bank of the river. It is believed that the fire originated in trash which accumulated in the sag of the roadway, ignited by a cigarette or match; it is known that the fire did not originate on the railway deck. The easterly span, 234 ft. long, had the cantilevered driveways and the timber deck burned for about half the span length. Two vertical posts of the downstream truss were badly crippled by heat and many of the stringers carrying the wagon driveways were so badly warped that they had to be replaced. This entire span was placed on falsework after the fire. Seventy-foot piles were required, the water being 45 ft. deep. By means of the gates of the Keokuk Dam the water was lowered 18 in. to permit capping the piles below permanent water level without under water sawing. A framed timber trestle was built on the caps. Railway traffic across the bridge was restored within four days after the fire, and in another week the wagon driveways were completed.

Stevens Point, Wis., Highway Bridge Fire.

On May 30 a six-span bridge crossing the Wisconsin River at Stevens Point, Wis., was practically destroyed by fire. It was an old structure, having been built in 1877, and originally carried an ordinary timber floor. But within recent years, according to M. W. Torkelson, engineer-secretary of the Wisconsin Highway Commission, a new floor was placed consisting of wood blocks on planks on modern stringers, all creosoted.

"The fire was first reported by tourists," Mr. Torkelson writes, "and when the city fire department arrived it had gained sufficient headway in the stringers under the floor to make it almost impossible to direct a stream of water against it. It seems that the fire spread very rapidly along the stringers underneath the floor, and while the upper portion still was practically intact, a very hot blaze was in progress underneath, and no headway could be made in fighting it until boats had been secured by which the fire could be attacked from beneath. The writer visited the bridge on June 1. At that time the two west spans of the bridge were completely wrecked and had collapsed into the river. The floor was almost completely burned off the two central spans, which were badly distorted by the heat. The upper portion of the floor of the two east spans was practically intact, but an examination of the stringers underneath the floor revealed that they were about two-thirds or three-fourths destroyed. The statement of the firemen who had assisted in fighting the fire was that water seemed to have very little if any effect."

Cimarron River Railway Bridge Fire.

On June 6, a bridge of the Atchison, Topeka and Santa Fe Railway over the Cimarron River at Guthrie, Okla., was partly destroyed by a fire of gasoline and oil from wrecked tank cars which went into the river as the result of a derailment at the approach to the bridge. This same fire also wrecked a county highway bridge 600 or 700 ft. downstream.

A southbound freight train approaching the bridge had a car leave the rails, and the portion of the train behind this car did considerable damage to the northerly span in crossing. It knocked the southerly span

off the piers and into the water, and eighteen cars of oil went down. Oil and gasoline in the river took fire. Subsequent inspection showed the south span to be a total loss while the north span was so much damaged as to make it uneconomical to attempt to re-use such of the old material as could be repaired. Beside these two spans, the pier between them had its limestone shafts so completely damaged by the heat that it will have to be rebuilt above the water line. Meanwhile, traffic is being taken care of by a temporary pile bridge.

Mercantile Fire Record.

The fire record files of the N. F. P. A. executive office have always contained a mercantile classification, although a fire record on the class has never been published. It was felt that the importance of the mercantile class warranted a detailed examination and after some study it was decided to analyze the 2212 fires recorded between the periods Jan. 1, 1910, and Jan. 1, 1923, by dividing them into eight distinct classes. The record divides as shown in the following table:

	Total	Number of Fires Sprinklered	Unsprinklered
Dry Goods Stores	420	222	198
Grocery Stores	242	108	134
Hardware Stores	209	99	110
General Stores	154	17	137
Furniture Stores	149	58	91
Shoe Stores	80	44	36
Miscellaneous Mercantiles	772	388	384
Multiple Occupancy	186	..	186
Total	2212	936	1276

The first six classes are self-explanatory. "Miscellaneous Mercantiles" provides for a variety of classes where fewer than eighty fires are recorded. This class includes book stores, candy stores, cigar stores, drug stores, jewelry stores, music stores, etc.

"Multiple Occupancy" provides for fires in business blocks where such fires are not extensive enough to be considered conflagrations. This class also includes fires in buildings housing several mercantile properties.

The following table shows the distribution of common causes of fire for all classes of mercantiles. It is interesting to note that approximately 93 per cent. of the known causes are common causes.

MERCANTILE FIRES

Common Causes.

	No. of Fires
Matches-Smoking	348
Heating	243
Lighting	155
Rubbish	142

Incendiary	83
Oily Material	76
Exposure	64
Power	41
Spontaneous Ignition	35
Defective Chimneys	27
Lightning	18
Locomotive Sparks	4
Miscellaneous	28
Total	1264
Special Hazard Causes	97
Unknown Cause	851
Total	2212

"Matches-Smoking" as usual is greatly in predominance as a fire cause. It is perhaps difficult to enforce "No Smoking" rules in mercantile establishments where many people not in the employ of the establishment are necessarily in the store or building, but it would seem that at least by good housekeeping, the posting of proper warnings, and the provision of adequate receptacles for discarded matches and cigarette butts, this hazard could be reduced.

The heating plant is another source of many fires. Proper construction and inspection could in most cases eliminate this hazard.

The loss data for the entire mercantile class given below, shows that slightly more than half of these 2212 fires caused losses of more than $5,000. This is an indication of the seriousness of the fire prevention problem in this class. The tremendous value of sprinkler systems in mercantiles is shown by the fact that 88 per cent. of the sprinklered fires were small loss fires and 79 per cent. of the unsprinklered fires were large loss fires.

ANALYSIS OF LOSS IN MERCANTILES

	Sprinklered Fires	Per Cent	Unsprinklered Fires	Per Cent	Total	Per Cent
Small Loss	826	88.3	219	17.2	1045	47.4
Large Loss	108	11.5	1010	79.1	1118	50.4
No Data	2	.2	47	3.7	49	2.2
Total	936	100.0	1276	100.0	2212	100.0

NOTE—Large loss fires are those causing damage of more than $5,000.

Dry Goods Stores.

In this class the common causes of fire fall in approximately the same order as for the entire mercantile class. The electric iron is the chief special hazard cause, but this cause is not as important as any of the chief common causes. The 181 sprinklered fires in this class were all extinguished or held in check by the sprinklers; a fine record.

Groceries.

The hazard of coffee roasting is the most prominent special hazard in groceries. There is quite a variety of special hazards in this class due to the number of different products handled. Sprinklers show a satisfactory

record of performance in 77 out of 82 sprinklered fires. The dry system is slightly more common than the wet system in this occupancy and three of the five sprinkler failures were in groceries having the dry system. In the unsprinklered properties, of the 136 fires, 96 caused losses of over $5,000 each.

Hardware Stores.

The causes of hardware store fires are practically all common causes and call for no special comment. Sprinklers were effective in all but one of 68 reported fires. Only nine of the 102 large loss fires were in sprinklered stores.

General Stores.

The heating plant was the leading common cause of fire in this class. Possibly this is due to the prevalence of the coal stove in the typical general store of the rural districts. Only fifteen of the 154 fires in this class were sprinklered fires and in all of these the sprinklers operated effectively. This class seems particularly subject to serious fires. The general store is usually in a country community and often remote from fire department protection. One hundred and seventeen of the 154 fires caused losses of over $5,000 and 116 of these were in unsprinklered stores.

Furniture Stores.

Heating and Matches-Smoking are the leading common causes in furniture stores. It is interesting to note that the five special hazard causes in this class are all hazards of manufacturing, probably due to maintenance of a repair department in the store. Four of the forty-five sprinklered fires show unsatisfactory operation of the sprinklers. Two out of three dry sprinkler systems in this class showed unsatisfactory operation. Approximately 87 per cent. of the unsprinklered fires caused damage of over $5,000.

Shoe Stores.

Sprinklers show a perfect record of performance in the thirty-four shoe store fires in which sprinklers opened. Over half of these fires were extinguished with one sprinkler head. Only one sprinklered fire caused a loss of over $5,000 as compared with twenty-seven of the thirty-six unsprinklered fires.

Miscellaneous Mercantiles.

Matches-Smoking and Heating head the list of causes of fire in this class. Sprinklers show an efficiency of 98 per cent. in 314 fires. In 62 per cent. of the sprinklered fires only one head opened. Ninety-one per cent. of the sprinklered fires were small loss fires and 71 per cent. of the unsprinklered fires were large loss fires. Of the 394 fires where data is available on the room in which fire occurred, over a third started in the basement. The basements of a good many mercantiles would not pass inspection. The basement is a too often neglected spot.

Multiple Occupancy.

The great majority of the fires in this class are of unknown cause. Most of these fires occur at night and are discovered by outsiders. None of the fires reported in this class were sprinklered and 96 per cent. of the losses are over $5,000. This class includes many mercantile buildings of inferior construction and miscellaneous occupancy and the hazard is naturally great.

Dry Goods Stores

Total Number of Fires Reported, 420.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes	Per Cent of Total Known Causes
Matches—Smoking	75	31.8	28.1
Heating	36	15.3	13.5
Rubbish or Sweepings	33	14.0	12.4
Lighting	23	9.8	8.7
Incendiary	20	8.5	7.5
Exposure	17	7.2	6.4
Oily Material	10	4.2	3.8
Power	6	2.5	2.3
Spontaneous Ignition	5	2.1	1.9
Lightning	5	2.1	1.9
Defective Chimney	2	.8	.6
Miscellaneous	4	1.7	1.5
Total	236	100.0	88.6

Special Hazard Causes.

	No. of Fires	Per cent of Special Causes	Per Cent of Total Known Causes
Electric Iron	20	66.7	7.5
Inflammable Liquids	4	13.4	1.5
Gas Iron	1	3.3	.4
Gas Pressing Machine	1	3.3	.4
Oxyacetylene Torch	1	3.3	.4
Sulphur Bleaching	1	3.3	.4
Gasoline Pipe Clogged	1	3.3	.4
Refuse Burner	1	3.3	.4
Total	30	100.0	11.4

	No. of Fires	Per Cent of Total
Common Causes	236	56.2
Special Hazard Causes	30	7.1
Total Known Causes	266	63.3
Unknown Cause	154	36.7
Total	420	100.0

Sprinkler Fire Record.

Effect of Sprinklers	No. of Fires	Per Cent
Extinguished Fire	152	84.0
Held Fire in Check	29	16.0
Total Satisfactory	181	100.0
Unsatisfactory	0	
Total	181	

There were 41 fires in which no sprinklers opened.

No. of Heads Opening	No. of Fires	Per Cent
1	90	49.7
2	42	23.2
3	18	9.9
4	11	6.1
5	6	3.3
6-9 incl.	7	3.9
10-25 incl.	6	3.3
26-50 incl.	1	.6
Total	181	100.0

Dry Goods Stores (continued).

COMPARISON OF WET AND DRY SYSTEMS.

	Wet System	Per Cent	Dry System	Per Cent	No Data	Total	Per Cent
Extinguished Fire ..	138	84.7	13	81.3	1	152	84.0
Held Fire in Check..	25	15.3	3	18.7	1	29	16.0
Total	163	100.0	16	100.0	2	181	100.0

Miscellaneous Statistics.

TIME OF DAY.

	No. of Fires	Per Cent
6 A. M. to 6 P. M.	140	33.2
6 P. M. to 6 A. M.	259	61.8
No Data	21	5.0
Total	420	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Outsider	163	38.9
Sprinkler Alarm ...	99	23.6
Employee	80	19.0
Watchman	24	5.7
Thermostat	19	4.5
Supervisory System .	16	3.8
No Data	19	4.5
Total	420	100.0

ANALYSIS OF LOSS.*

	Sprinklered Fires	Per Cent	Unsprinklered Fires	Per Cent	Total	Per Cent
Small Loss ...	183	82.5	43	21.6	226	53.8
Large Loss ...	39	17.5	149	75.3	188	44.8
No Data	—	—	6	3.1	6	1.4
Total	222	100.0	198	100.0	420	100.0

*Large loss fires are those causing loss of more than $5,000.

ROOM IN WHICH FIRE OCCURRED.

	No. of Fires	Per Cent of Total with Data
Basement	66	33.7
Stock	27	13.8
Storage	14	7.1
Shipping	14	7.1
Boiler	12	6.1
Outside	11	5.6
Office	6	3.1
Sales	6	3.1
Miscellaneous	40	20.4
Total with Data	196	100.0
No Data	224	
Total	420	

Groceries

Total Number of Fires Reported, 242.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes	Per Cent of Total Known Causes
Matches—Smoking	44	34.6	27.4
Heating	16	12.6	9.9
Lighting	15	11.8	9.3
Incendiary	11	8.7	6.8
Rubbish or Sweepings	8	6.3	5.0
Power	6	4.7	3.7
Oily Material	6	4.7	3.7
Spontaneous Ignition	6	4.7	3.7
Exposure	6	4.7	3.7
Defective Chimney	3	2.4	1.9
Lightning	2	1.6	1.2
Miscellaneous	4	3.2	2.5
Total	127	100.0	78 8

Special Hazard Causes.

	No. of Fires	Per Cent of Special Causes	Per Cent of Total Known Causes
Coffee Roasting	18	53.0	11.3
Spice Pulverizer	4	11.9	2.6
Explosion	3	8.9	1.9
Inflammable Liquids	2	5.9	1.2
Grinding Machine	1	2.9	.6
Tar Boiling Over	1	2.9	.6
Sugar Mill	1	2.9	.6
Frying Doughnuts	1	2.9	.6
Hot Peanuts	1	2.9	.6
Ripening Bananas	1	2.9	.6
Auto Truck Caught Fire	1	2.9	.6
Total	34	100.0	21.2

	No. of Fires	Per Cent of Total
Common Causes	127	52.5
Special Hazard Causes	34	14.0
Total Known Causes	161	66.5
Unknown Cause	81	33.5
Total	242	100.0

Groceries (continued).

Sprinkler Fire Record.

Effect of Sprinklers	No. of Fires	Per Cent
Extinguished Fire	66	80.5
Held Fire in Check	11	13.4
Total Satisfactory	77	93.9
Unsatisfactory	5	6.1
Total	82	100.0

There were 26 fires in which no sprinklers opened.

No. of Heads Opening	No. of Fires	Per Cent
1	37	45.2
2	14	17.2
3	5	6.1
4	4	4.9
5	1	1.2
6-9 incl.	5	6.1
10-25 incl.	8	9.3
26-50 incl.	3	3.8
51-100 incl.	1	1.2
101-200 incl.	1	1.2
No Data	3	3.8
Total	82	100.0

COMPARISON OF WET AND DRY SYSTEMS.

	Wet System	Per Cent	Dry System	Per Cent	No Data	Total	Per Cent
Extinguished Fire	31	81.6	34	81.0	1	66	80.5
Held Fire in Check	6	15.8	5	11.9	0	11	13.4
Unsatisfactory	1	2.6	3	7.1	1	5	6.1
Total	38	100.0	42	100.0	2	82	100.0

Miscellaneous Statistics.

TIME OF DAY.

	No. of Fires	Per Cent
6 A. M. to 6 P. M.	93	38.4
6 P. M. to 6 A. M.	134	55.4
No Data	15	6.2
Total	242	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Outsider	99	40.9
Employee	72	29.8
Sprinkler Alarm	32	13.4
Watchman	22	9.1
Supervisory System	7	2.8
Thermostat	3	1.2
No Data	7	2.8
Total	242	100.0

ANALYSIS OF LOSS.

	Sprinklered Fires	Per Cent	Unsprinklered Fires	Per Cent	Total	Per Cent
Small Loss	95	88.0	35	26.2	130	53.7
Large Loss	13	12.0	96	71.6	109	45.1
No Data	..	..	3	2.2	3	1.2
Total	108	100.0	134	100.0	242	100.0

Groceries (continued).

ROOM IN WHICH FIRE OCCURRED.

	No. of Fires	Per Cent of Total with Data
Basement	29	23.4
Storage	19	15.3
Coffee Roasting	14	11.3
Shipping and Packing	9	7.3
Boiler	8	6.4
Miscellaneous	45	36.3
Total with Data	124	100.0
No Data	118	
Total	242	

Hardware Stores

Total Number of Fires Reported, 209.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes
Matches—Smoking	24	19.5
Heating	23	18.7
Rubbish or Sweepings	17	13.8
Oily Material	17	13.8
Lighting	13	10.6
Power	6	4.9
Spontaneous Ignition	5	4.1
Lightning	4	3.3
Exposure	4	3.3
Incendiary	3	2.3
Defective Chimney	2	1.6
Miscellaneous	5	4.1
Total	123	100.0

Special Hazard Causes.

	No. of Fires	Per Cent of Special Causes
Inflammable Liquids	4	66.6
China Kiln	1	16.7
Blow Torch	1	16.7
Total	6	100.0

	No. of Fires	Per Cent of Total
Common Causes	123	59.0
Special Hazard Causes	6	2.9
Total Known Causes	129	61.9
Unknown Cause	80	38.1
Total	209	100.0

Hardware Stores (continued).

Sprinkler Fire Record.

Effect of Sprinklers	No. of Fires	Per Cent
Extinguished Fire	59	86.9
Held Fire in Check	8	11.6
Total Satisfactory	67	98.5
Unsatisfactory	1	1.5
Total	68	100.0

There were 22 fires in which no sprinklers opened.

No. of Heads Opening	No. of Fires	Per Cent
1	40	58.8
2	11	16.3
3	2	2.9
4	3	4.4
5	2	2.9
6-9 incl.	6	8.8
26-50 incl.	4	5.9
	68	100.0

COMPARISON OF WET AND DRY SYSTEMS.

	Wet System	Per Cent	Dry System	Per Cent	Total	Per Cent
Extinguished Fire	41	87.3	18	85.7	59	86.7
Held Fire in Check	5	10.6	3	14.3	8	11.8
Unsatisfactory	1	2.1	..	..	1	1.5
Total	47	100.0	21	100.0	68	100.0

Miscellaneous Statistics.

TIME OF DAY.

	No. of Fires	Per Cent
6 A. M. to 6 P. M.	87	41.6
6 P. M. to 6 A. M.	112	53.6
No Data	10	4.8
Total	209	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Outsider	99	47.4
Employee	47	22.5
Sprinkler Alarm	35	16.8
Watchman	9	4.3
Thermostat	7	3.3
Supervisory System	5	2.4
No Data	7	3.3
Total	209	100.0

ANALYSIS OF LOSS.

	Sprinklered Fires	Per Cent	Unsprinklered Fires	Per Cent	Total	Per Cent
Small Loss	90	91.0	11	10.0	101	48.2
Large Loss	9	9.0	93	84.5	102	48.9
No Data	..	..	6	5.5	6	2.9
Total	99	100.0	110	100.0	209	100.0

ROOM IN WHICH FIRE OCCURRED.

	No. of Fires	Per Cent of Total with Data
Basement	37	36.0
Storage	14	13.6
Boiler	9	8.7
Shipping	9	8.7
Stock	8	7.8
Miscellaneous	26	25.2
Total with Data	103	100.0
No Data	106	
Total	209	

General Stores

Total Number of Fires Reported, 154.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes
Heating	17	24.7
Lighting	15	21.8
Incendiary	13	18.8
Matches—Smoking	9	13.0
Exposure	5	7.2
Rubbish or Sweepings	3	4.4
Spontaneous Ignition	3	4.4
Defective Chimney	2	2.9
Lightning	1	1.4
Oily Material	1	1.4
Total	69	100.0

	No. of Fires	Per Cent of Total
Common Causes	69	44.7
Special Hazard Causes	..	..
Total Known Causes	69	44.7
Unknown Cause	85	55.3
Total	154	100.0

Sprinkler Fire Record.

Effect of Sprinklers	No. of Fires	Per Cent
Extinguished Fire	11	73.4
Held Fire in Check	4	26.6
Total Satisfactory	15	100.0
Unsatisfactory	..	
Total	15	

No. of Heads Opening	No. of Fires	Per Cent
1	7	46.6
2	5	33.3
4	2	13.5
6-9 inclusive	1	6.6
Total	15	100.0

There were 2 fires in which no sprinklers opened.

Note:—Sprinklers in these 15 fires were all wet system.

Miscellaneous Statistics.

TIME OF DAY.

	No. of Fires	Per Cent
5 A. M. to 6 P. M.	37	24.0
5 P. M. to 6 A. M.	104	67.6
No Data	13	8.4
Total	154	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Outsider	98	63.6
Employee	27	17.5
Sprinkler Alarm	7	4.5
Watchman	4	2.6
Supervisory System	1	.7
Thermostat	1	.7
No Data	16	10.4
Total	154	100.0

General Stores (continued).

ANALYSIS OF LOSS.

	Sprinklered Fires	Per Cent	Unsprinklered Fires	Per Cent	Total	Per Cent
Small Loss	16	94.1	19	13.9	35	22.8
Large Loss	1	5.9	116	84.6	117	75.9
No Data	..	..	2	1.5	2	1.3
Total	17	100.0	137	100.0	154	100.0

Furniture Stores

Total Number of Fires Reported, 149.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes
Heating	21	22.4
Matches—Smoking	20	21.3
Lighting	15	16.0
Rubbish or Sweepings	10	10.6
Oily Material	8	8.5
Spontaneous Ignition	5	5.3
Exposure	5	5.3
Incendiary	4	4.3
Power	3	3.2
Defective Chimney	2	2.1
Lightning	1	1.0
Total	94	100.0

Special Hazard Causes.

	No. of Fires	Per Cent of Special Causes
Inflammable Liquids	2	40.0
Glue Pot	1	20.0
Circular Saw	1	20.0
Blower System	1	20.0
Total	5	100.0

	No. of Fires	Per Cent of Total
Common Causes	94	63.0
Special Hazard Causes	5	3.3
Total Known Causes	99	66.3
Unknown Cause	50	33.7
Total	149	100.0

Furniture Stores (continued).

Sprinkler Fire Record.

Effect of Sprinklers	No. of Fires	Per Cent
Extinguished Fire	33	73.3
Held Fire in Check	8	17.8
Total Satisfactory	41	91.1
Unsatisfactory	4	8.9
Total	45	100.0

There were 13 fires in which no sprinklers opened.

No. of Heads Opening	No. of Fires	Per Cent
1	15	33.3
2	15	33.3
3	4	8.9
5	1	2.2
6-9 incl.	3	6.7
10-25 incl.	1	2.2
26-50 incl.	2	4.5
51-100 incl.	3	6.7
Over 300	1	2.2
Total	45	100.0

COMPARISON OF WET AND DRY SYSTEMS.

	Wet System	Per Cent	Dry System	Per Cent	Total	Per Cent
Extinguished Fire	32	76.2	1	33.3	33	73.3
Held Fire in Check	8	19.0	..	..	8	17.8
Unsatisfactory	2	4.8	2	66.7	4	8.9
Total	42	100.0	3	100.0	45	100.0

Miscellaneous Statistics.

TIME OF DAY.

	No. of Fires	Per Cent
6 A. M. to 6 P. M.	74	49.6
6 P. M. to 6 A. M.	66	44.4
No Data	9	6.0
Total	149	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Outsider	61	41.0
Employee	59	39.6
Sprinkler Alarm	13	8.7
Watchman	6	4.0
Supervisory System	3	2.0
No Data	7	4.7
Total	149	100.0

ANALYSIS OF LOSS.

	Sprinklered Fires	Per Cent	Unsprinklered Fires	Per Cent	Total	Per Cent
Small Loss	46	79.3	9	9.9	55	36.9
Large Loss	11	19.0	79	86.8	90	60.4
No Data	1	1.7	3	3.3	4	2.7
Total	58	100.0	91	100.0	149	100.0

ROOM IN WHICH FIRE OCCURRED.

	No. of Fires	Per Cent of Total with Data
Basement	31	36.0
Storage	14	16.4
Boiler	9	10.4
Miscellaneous	32	37.2
Total with Data	86	100.0
No Data	63	
Total	149	

Shoe Stores

Total Number of Fires Reported, 80.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes
Matches—Smoking	16	38.1
Lighting	8	19.0
Rubbish or Sweepings	6	14.4
Incendiary	3	7.1
Exposure	3	7.1
Heating	3	7.1
Power or Transmission	1	2.4
Defective Chimney	1	2.4
Miscellaneous	1	2.4
Total	42	100.0

Special Hazard Causes.

	No. of Fires	Per Cent of Special Causes
Electric Iron	2	50.0
Buffing	1	25.0
Explosion	1	25.0
Total	4	100.0

	No. of Fires	Per Cent of Total
Common Causes	42	52.5
Special Hazard Causes	4	5.0
Total Known Causes	46	57.5
Unknown Cause	34	42.5
Total	80	100.0

Sprinkler Fire Record.

Effect of Sprinklers	No. of Fires	Per Cent
Extinguished Fire	29	85.3
Held Fire in Check	5	14.7
Total Satisfactory	34	100.0
Unsatisfactory	..	
Total	34	

There were 10 fires in which no sprinklers opened.

No. of Heads Opening	No. of Fires	Per Cent
1	18	53.0
2	10	29.3
3	4	11.8
4	2	5.9
Total	34	100.0

COMPARISON OF WET AND DRY SYSTEMS.

	Wet System	Per Cent	Dry System	Per Cent	Total	Per Cent
Extinguished Fire	27	87.0	1	33.3	28	82.4
Held Fire in Check	4	13.0	2	66.7	6	17.6
Total	31	100.0	3	100.0	34	100.0

Shoe Stores (continued).

Miscellaneous Statistics.

TIME OF DAY.

	No. of Fires	Per Cent
6 A. M. to 6 P. M.	32	40.0
6 P. M. to 6 A. M.	47	58.7
No Data	1	1.3
Total	80	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Outsider	34	42.5
Employee	16	20.0
Sprinkler Alarm	12	15.0
Watchman	4	5.0
Thermostat	4	5.0
Supervisory System	3	3.8
No Data	7	8.7
Total	80	100.0

ANALYSIS OF LOSS.

	Sprinklered Fires	Per Cent	Unsprinklered Fires	Per Cent	Total	Per Cent
Small Loss	43	97.7	6	16.7	49	61.2
Large Loss	1	2.3	27	75.0	28	35.0
No Data	..	..	3	8.3	3	3.8
Total	44	100.0	36	100.0	80	100.0

Miscellaneous Mercantiles

(Book Stores, Candy Stores, Cigar Stores, Drug Stores, Jewelry Stores, Music Stores, etc.)

Total Number of Fires Reported, 772.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes
Matches—Smoking	148	29.2
Heating	104	20.6
Rubbish or Sweepings	60	11.8
Lighting	59	11.6
Oily Material	33	6.5
Exposure	23	4.5
Incendiary	21	4.1
Power	19	3.7
Defective Chimney	11	2.2
Spontaneous Ignition	10	2.0
Lightning	4	.8
Locomotive Sparks	2	.4
Miscellaneous	13	2.6
Total	507	100.0

Miscellaneous Mercantiles (continued).

Special Hazard Causes.

	No. of Fires	Per Cent of Special Causes
Inflammable Liquids	6	33.3
Pressing Iron	4	22.2
Cigar Lighter	2	11.1
Gasoline Blow Torch	2	11.1
Coffee Urn	1	5.5
Vulcanizing	1	5.5
Incinerator	1	5.5
Soldering Torch	1	5.5
Total	18	100.0

	No. of Fires	Per Cent of Total
Common Causes	507	65.8
Special Hazard Causes	18	2.3
Total Known Causes	525	68.1
Unknown Cause	247	31.9
Total	772	100.0

Sprinkler Fire Record.

Effect of Sprinklers	Fires No. of	Cent Per
Extinguished Fire	265	84.3
Held Fire in Check	43	13.8
Total Satisfactory	308	98.1
Unsatisfactory	6	1.9
Total	314	100.0

There were 74 fires in which no sprinklers opened.

No. of Heads Opening	No. of Fires	Per Cent
1	194	62.4
2	63	20.2
3	20	6.4
4	10	3.2
5	4	1.3
6-9 inclusive	9	2.9
10-25 inclusive	9	2.9
51-100 inclusive	2	.7
	311	100.0
No Data	3	
Total	314	

COMPARISON OF WET AND DRY SYSTEMS.

	Wet System	Per Cent	Dry System	Per Cent	No Data	Total	Per Cent
Extinguished Fire	240	83.7	25	89.3	..	265	84.5
Held Fire in Check	40	14.5	3	10.7	..	43	13.7
Unsatisfactory	5	1.8	..	..	1	6	1.8
Total	285	100.0	28	100.0	1	314	100.0

Miscellaneous Mercantiles (continued).

Miscellaneous Statistics.

TIME OF DAY.

	No. of Fires	Per Cent
6 A. M. to 6 P. M.	295	38.2
6 P. M. to 6 A. M.	441	57.2
No Data	36	4.6
Total	772	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Outsider	280	36.2
Employee	188	24.4
Sprinkler Alarm	145	18.8
Watchman	31	4.0
Thermostat	29	3.8
Supervisory System	24	3.1
No Data	75	9.7
Total	772	100.0

ANALYSIS OF LOSS.

	Sprinklered Fires	Per Cent	Unsprinklered Fires	Per Cent	Total	Per Cent
Small Loss	352	90.7	90	23.4	442	57.2
Large Loss	34	8.8	274	71.3	308	39.9
No Data	2	.5	20	5.3	22	2.9
Total	388	100.0	384	100.0	772	100.0

ROOM IN WHICH FIRE OCCURRED.

	Fires No. of	Per Cent of Total with Data
Basement	150	38.0
Boiler	44	11.2
Storage	41	10.4
Hall	22	5.6
Stock	17	4.3
Office	16	4.1
Outside	14	3.6
Elevator Shaft	11	2.8
Shipping	10	2.5
Show Room or Window	6	1.5
Stair Enclosure	5	1.3
Miscellaneous	58	14.7
Total with Data	394	100.0
No Data	378	
Total	772	

Multiple Occupancy

(Business Blocks, Groups of Stores, etc.)

Total Number of Fires Reported, 186.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent
Heating	23	33.5
Matches—Smoking	12	17.5
Incendiary	8	11.6
Lighting	7	10.1
Rubbish or Sweepings	5	7.2
Defective Chimney	4	5.8
Inflammable Liquids	2	2.9
Locomotive Sparks	2	2.9
Lightning	1	1.4
Oily Material	1	1.4
Spontaneous Ignition	1	1.4
Exposure	1	1.4
Miscellaneous	2	2.9
Total	69	100.0

	No. of Fires	Per Cent of Total
Common Causes	69	37.0
Unknown Cause	117	63.0
Total	186	100.0

Miscellaneous Statistics.

TIME OF DAY.

	No. of Fires	Per Cent
6 A. M. to 6 P. M.	34	18.3
6 P. M. to 6 A. M.	127	68.3
No Data	25	13.4
Total	186	100.0

HOW DISCOVERED.

	No. of Fires	Per Cent
Outsider	134	72.0
Employee	20	10.8
Watchman	6	3.2
No Data	26	14.0
Total	186	100.0

ANALYSIS OF LOSS.

	No. of Fires	Per Cent
Small Loss	6	3.3
Large Loss	176	94.5
No Data	4	2.2
Total	186	100.0